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INSTRUCTIONAL-CUM-PRACTICAL MANUAL

On

BASIC MATERIALS AND RELATED WORKSHOP

for

LINEMAN VOCATION CLASS-XII

Contributors

Shri G.B.Singh	Shri P.C.Singhal
Shri R.K.Saxena	Shri H.L.Bhutani
Shri V.K.Singla	Shri A.P.Verma
Shri J.S.Kalra	Shri S.Ray

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DEPARTMENT OF VOCATIONALIZATION OF EDUCATION
NATIONAL COUNCIL OF EDUCATIONAL RESEARCH AND TRAINING
SRI AUROBINDO MARG, NEW DELHI- 110016.

PREFACE

Ever since the introduction of Vocational Education in our School System by Several States and Union Territories in our Country, the paucity of appropriate instructional materials has been felt as one of the major constraints in implementation of the programme and a source of great hardship to pupils offering Vocational Studies at the higher Secondary Stage.

The Department of Vocationalization of Education (DVE) of the National Council of Educational Research and Training (NCERT), New Delhi has started a modest programme of developing instructional materials of diverse types to fill up this void in all major areas of Vocational Education. The task is too gigantic to be completed by any single agency but the model materials being developed by us might provide guidance and impetus to the authors and agencies desiring to contribute in this area. These are based on the national guidelines developed by a working group of experts constituted by the NCERT. The present Manual is on BASIC MATERIALS AND RELATED WORKSHOP for Lineman Vocation Class-XII. It contains practical exercises to be performed by the students with simple steps to follow, precautions to be taken and data to be observed and recorded in observation sheet. Each experiment is complete with specific objectives, theoretical information, behavioural out come and questions for evaluation, etc. It is hope that the students will find them immensely useful.

The pages that follow contain a draft of the manual which will be finalised after obtaining the feedback from the students, teachers and others concerned. The materials will then be published in printed form.

The users are requested to complete the questionnaire appended and return the same to us. Comments and suggestions for improvement of the material are cordially invited.

The material has been developed by a group of experts as authors in a Workshop held at the Advanced Vocational Training System, Industrial Training Institute, Faridabad from 24 February to 2 March 1984. Their names are mentioned elsewhere and their contributions are admirably acknowledged. This material was edited and finalised by another group of experts at our Deptt. from 9 to 12 March 1984. Our thanks are also due to the experts for taking pain to varyfy the authenticity of contents of the Manual. Shri Sachchidananda Ray, Lecturer in Technology deserves special thanks for editing and bringing the material in the present form. The assistance rendered by the Staff Members of ITI, Faridabad and DVE, NCERT for bringing out this manual is also thankfully acknowledged.

ARUN K MISHRA
Professor and Head
Department of Vocationalization
of Education
National Council of Educational Research
and Training
Sri Aurobindo Marg, New Delhi-110016.

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INTRODUCTION

The Vocationalization of higher secondary education in the 10+2 pattern of schooling has been introduced by Several States and Union Territories in the Country. The implementation of this programme received further encouragement by the Conference of Education Ministers in 1981. With the priorities laid down in the Sixth plan a few more States are seriously planning to Switch Over to 10+2+3 pattern of education and to implement Vocationalization at the plus two stage.

The implementation of the programme for the States and Union Territories has revealed that there is a great dearth of appropriate instructional materials. Since the vocational Courses laid a great emphasis on practical training it has become necessary to prepare Instructional-cum-Practical Manuals best suited for these courses. The absence of appropriate instructional material has been one of the major constraints in the implementation of the programme and a source of great hardship to students offering Vocational Studies at the plus two stage.

To develop models of instructional materials, the Department Constituted a Working Group to formulate guidelines for the development of instructional materials and to prepare brief examples units. National guidelines were developed by this Working Group for preparation of instructional material.

The manual on BASIC MATERIALS AND RELATED WORKSHOP for Lineman Vocation Class-XII has been developed based on the guidelines recommended by Working Group. This manual is envisaged to help both teachers and students. Each experiment

is complete with specific objective, introductory information and related theory, equipment and materials, diagram, procedure, record of observation, precaution and questions for evaluation. In order to acquaint the Students about each experiment, the teacher should provide them with required theoretical knowledge or information related to the experiment. This will help the students for proper understanding of the experiment and enable them to perform the experiment properly and effectively.

In order to meet the stipulated objectives, the experiments include the Study and operation of tools and instruments which a lineman would be required to use in his professional career, operation of machines, visit and study of Sub-Station, Power-Station and Factory. It is believed that the time spent in the laboratory and the field study will help the students to acquire sufficient confidence to handle his job with deligence.

The evaluation of the experiments performed by the students shall be based on the specific objectives. The teacher shall evaluate all the aspects which are relevant to achieve the specific objectives. This will contribute towards the "expected behavioural out come". Evaluation is an important aspect of performing the experiments. Each experiment should be assessed through evaluation based on knowledge, acquired skills and competencies, attitude and aptitude towards work, experiment performance, application, maintenance of experiment record. Tabular representation of suggested evaluation scheme is given

below:

Sl. No.	Components	Marks allotted	Marks obtained
1.	Knowledge	20	
2.	Acquired Skills and Competencies	35	
3.	Attitude and Aptitude towards Work	15	
4.	Experiment performance	10	
5.	Application	10	
6.	Maintenance of Experiment Record	10	
	Total Marks	100	

At the end of each experiment, some questions for evaluation are given. The students shall answer these questions after the completion of each experiment and teacher shall examine them. If required, necessary corrections and suitable suggestions should be incorporated by the teacher. However, the answer to these questions should not be considered for the purpose of awarding final grade or marks.

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EXPERIMENT/PRACTICAL NO.1

TITLE OF EXPERIMENT/PRACTICAL

Simple practice of soldering.

SPECIFIC OBJECTIVE.

To acquire skill in soldering.

INTRODUCTORY INFORMATION AND RELATED THEORY

INFORMATION

The lineman is required to do soldering in his day today work e.g. joining of cables, filling of thimbles or lugs etc.

THEORY:- Soldering is a quick method of making joints in light articles made from steel/copper brass and for joining electrical cables and wires. A soldered joint cannot be put to strength as it is s weak joint. Soldering is a joining of two metals by using a third metal as filler metal having the melting point much lower than those of the metals to be joined. In this method, the solder is brought to the molten stage and is supplied to the joint whereas the parent metals remain at temperature below their melting points. For successful soldering the main requirement is the cleanliness of the surfaces to be joined and for this purpose, a flux is a must. A flux is a chemical compound used for cleaning the surfaces and preventing oxidation. Various types of fluxes are available to be used for different metals to be soldered. Some of these are:-

1. Ammonium chloride (NH_4CL)
2. Killed spirit (Freshly prepared $Zncl_2$ from Zn) zinc by the chemical reaction of Hcl for G.I. soldering.
3. Resin, for aluminium and copper commercially known as fluxite.

N.B. For soldering of electrical connections, special flux cored solder tubes are available in the market.

EQUIPMENT AND MATERIALS

EQUIPMENT

1. Electric soldering irons of different power capacity depending upon the thickness of the metals to be soldered.

(more the thickness higher the power) (Refer Fig.1.1)

ii. Soldering iron bit.

iii. Fire-hearth.

iv. Hand operated blower.

v. Blow Lamp

vi. Soldering Pot.

.. Materials:- Solders (sticks or tubes) Flux, material to be soldered(wires, cables etc.)

PROCEDURE

ELECTRIC SOLDERING

(i Clean the surfaces to be joined thoroughly with emery cloth or file.

ii. Heat the edges to be joined with the soldering iron, apply flux and then tin the edges with solder.

iii. Apply flux to the edges again and overlap them.

iv. Apply solder at the joining area using the soldering iron.

v. Allow the joint to cool down without disturbance.

vi. . Check the joint by pulling them apart.

vii. If the joint is not proper, clean the edges again and repeat the above steps from (i) to (v) sequentially.

If the electric soldering iron is not available then the ordinary soldering iron can be used which can be heated in the fire-hearth. Each time the soldering bit is removed from the heat, it should be cleaned by rubbing it against a hard durface and then flux should be applied. The above procedure is applicable to this method as well.

POT SOLDERING

1. Clean the cable ends to be joined, using emery cloth or file.

2. Insert the cleaned ends into the coupling sleeve.

3. Tighten the screws.

4. Heat the sleeve with blow-lamp.

5. Apply flux properly with brush.

6. Pour the molten solder into the sleeve.
7. Allow the joint to cool down without disturbance.

PRECAUTIONS

1. Observe extreme cleanliness during soldering operations.
2. Ensure proper application of flux to all wires.
3. Temperature of solder should be maintained between 300° - 325° C. If the higher limit is exceeded, the ~~p~~ conductor will get annealed resulting in lower tensile strength, and the flux will get charred. However, the temperature should be maintained near the upper limit to allow for heat loss during the transfer of solder from the pot to the joint. Use a thermometer for the purpose.

The conductor, accessories and solder should all be kept at nearly the same temperature (300°C) during soldering.

Any dross that might be formed on the surface of the solder, should be removed.

The conductor should be pre-tinned to a shinning mirror-like finish.

Use a small soldering iorn for small joints.

QUESTIONS FOR EVALUATION

What is a solder?

What are the functions of flux?

What are the various types of fluxes commercially available?

Why cleaning of the surfaces to be joined essential?

What do you mean by a dry soldering?

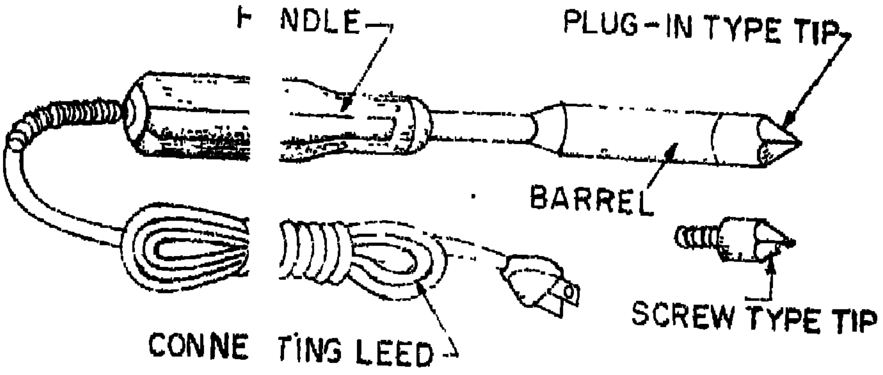
(vi) Why tinning of the ends of the wires to be joined is required before these are soldered?

(vii) Why the edges to be joined are heated before the application of solder?

(viii) What precautions are to be observed to get a good soldered joint?

REFERENCES.

1. Workshop technology by Raghuwanshi.
2. -do- Pt.I by W.A.J. Chapman.



SOLDERING IRON

Fig. 1.1

EXPERIMENT/PRACTICAL 2

1. TITLE OF EXPERIMENT/PRACTICAL

Simple practice of brazing.

2. SPECIFIC OBJECTIVES

(i) To acquire skill in hearth brazing.

(ii) To acquire skill in gas brazing.

3. INTRODUCTORY INFORMATION AND RELATED THEORY :

(a) Information

At times the lineman is required to make strong joints (harder than the soldering). For this prupose, he is required to know the brazing process.

(b) Related Theory.

Brazing is similar to soldering except that the solder used in this case has higher melting point and requires different flux (Borax). In this method the surfaces those are to be joined are heated to a temprature higher than the m.p. of the spelter (Brass is the brazing material). The spelter enters into the joining gap due to capilary action. The joint is allowed to cool and solidify. Spelter is available in the form of rods, granules and strips. For rods and strips flux is applied separately whereas granules and flux are mixed and then applied.

EQUIPMENT AND MATERIALS

A. EQUIPMENT

(a) Hearth Brazing.

(1) Brazing Hearth.

(2) Clamps.

(3) Set of fire tongs.

(b) Blow pipe brazing. (Gas)

(1) Oxygen gas cylinder.

(2) Acetylene gas cylinder

(3) Pressure gauges.

(4) Hose pipe.

(5) Blow pipe.

(6) Gas Lighter.

(7) Goggles.

(8) Emery paper, file.

B. Materials

(1) Coke in case of hearth brazing.

(2) Flux (Borax)

(3) Spelter.

5. PROCEDURE A (Hearth Brazing)

i) Clean the surfaces to be joined using emery paper, file or wire brush.

ii) Lap the surfaces.

iii) Apply the flux.

iv) Cut the spelter sheet to the size and insert it in-between the lapped surfaces.

v) Clamp the joining area.

vi) Keep the clamped surfaces in the hearth.

vii) Heat the surfaces to a temp. about 900°C at which the spelter will melt.

viii) Switch off the air to the hearth and allow the jointing surfaces to remain in the hearth for 5 to 10 minutes to attain proper adhesion.

ix) Remove the surfaces from the hearth and allow them to cool in open.

x) Remove the clamps when the joint is at room temperature.

B. Blow Pipe Brazing.

i) Clean the surfaces thoroughly with emery paper and file.

ii) Lap the surfaces to be joined and hold them.

iii) Heat the surfaces thoroughly and uniformly upto a temp. of 900°C (red hot) using the blow pipe.

(4) Hose pipe.

(5) Blow pipe.

(6) Gas Lighter.

(7) Goggles.

(8) Emery paper, file.

B. Materials

(1) Coke in case of hearth brazing.

(2) Flux (Borax)

(3) Spelter.

5. PROCEDURE A (Hearth Brazing)

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ix) Remove the surfaces from the hearth and allow them to cool in open.

x) Remove the clamps when the joint is at room temperature.

B. Blow Pipe Brazing.

i) Clean the surfaces thoroughly with emery paper and file.

ii) Lap the surfaces to be joined and hold them.

iii) Heat the surfaces thoroughly and uniformly upto a temp. of 900 °C (red hot) using the blow pipe.

v) Apply the spelter at the joining surfaces by first dipping it in the flux. Keep on applying spelter along with flux till the lap cavity or the groove cut is filled. Use slight excess oxygen flame.

vi) Allow the surfaces to cool down to room temparature without disturbance.

PRECAUTIONS

(1) Observe extreme cleanliness during brazing operations.

(2) Ensure proper application of flux to the surfaces to be joined.

(3) Heat the surfaces to be joined to a temperature above the melting temperature of spelter.

(4) Keep the surfaces soaked at brazing temperature for 5 to 10 minutes.

(5) Do not disturb the surfaces to be joined till the spelter solidfies completely.

(6) Avoid excessive flux.

(7) Remove slag completely from brazed area.

(8) Soak brazed part in hot water and clean it with wire brush.

7. QUESTION FOR EVALUATION

(1) What is the difference between brazing and soldering?

(2) Why the surfaces are not to be disturbed during the solidification of spelter?

(3) Why the surfaces to be joined are heated to a temperature higher than that of the m.p. of spelter?

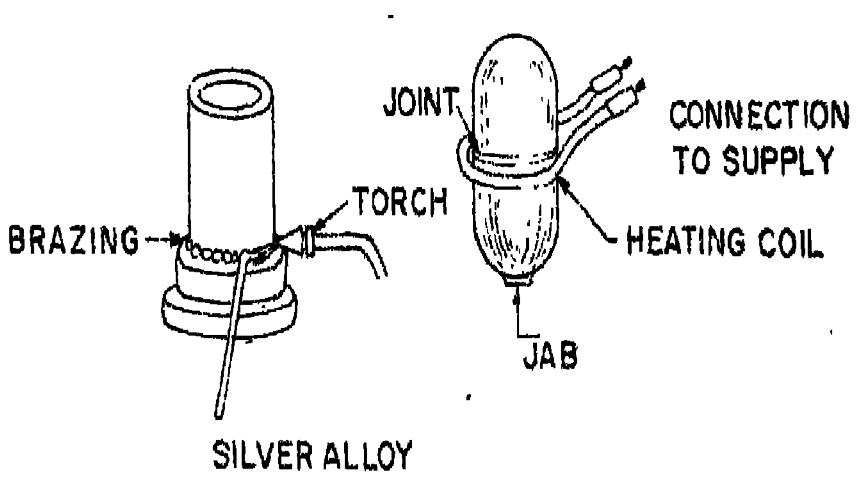
(4) Why soaking is required?

(5) Where brazing is preferred to soldering?

(6) Narrate the causes of defects in brazed joint.

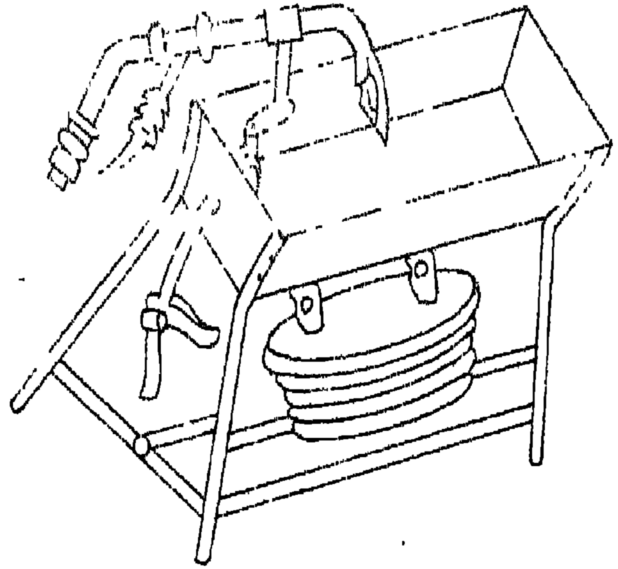
References

1. Workshop Technology by Raghuwanshi.
2. Workshop Technology Part I by W.A.S. Chapman.



BRAZING OPERATION

Fig.2.2



BRAZING FURNACE

Fig.2.1

EXPERIMENT/PRACTICAL NO.3

1. TITLE OF EXPERIMENT/PRACTICAL

Simple practice of welding (gas)

2. SPECIFIC OBJECTIVE

To acquire skill in Oxy-acetylene gas welding.

3. INTRODUCTORY INFORMATION AND RELATED THEORY.

Oxy-acetylene gas welding is the most common method and the lineman is supposed to know it.

Related Theory

Fusion welding is a joining of two similar metals by heating the edges to be joined to a fusion temperature (metals brought to molten stage) and using a third fillermetal of the same composition as that of the metals being joined. In brazing the metals to be joined are not brought to molten stage but are heated between 600°C to 900°C. A brased joint is weaker than welded joint. In gas welding the heat source is the combustion of acetylene gas with oxygen. The character of the flame (Reducing,Neutral or Oxidising) depends upon the proportional amount of acetylene participating in combustión with oxygen.

$$C_{2.}H_2 + O_2 \longrightarrow CO + H_2O + \text{heat}$$

$$2CO + O_2 \longrightarrow CO_2 + \text{heat}$$

4. EQUIPMENT AND MATERIALS

A. Equipment

1. Oxy-acetylene gas welding set (Refer fig.3.1)
2. Goggles
3. Set of nozzles along with the blow-pipe.
4. Spark lighter
5. Chipping hammer
6. Set of tongs.
7. Hand gloves
8. C-clamps
9. [illegible]

B. b Material

1. Material to be welded
2. Filler rods
3. Flux

5. PROCEDURE

1. Clean the edges of surfaces to be a welded.
2. Lap the surfaces.
3. Arrange the oxygen and acretylen cylinders in the upright position.
4. Check the gas cylinder valves for any foreign particle and fix the respective regulator on each cylinder and fix the appropriate hose pipes to the regulators.
5. Open the valves on each cylinder and adjust the line pressures of acetylene gas and oxygen gas according to the size of the nozzle (0.4kg./cm^2 for oxygen and 0.2 kg./cm^2 for acetylene) clean the nozzle for any sticking foreign particle by blowing through oxygen gas for sometime.
7. Open the acetylene gas first and start the flame with spark lighter and then adjust the oxygen gas amount to get the required character of the flame.
8. Heat the surfaces to be joined by playing the flame, keeping an angle of 60^0 to 70^0 of the nozzle with the surface. When the surfaces are brought to the fusion temperature, insert the flux dipped filler rod at the heated area and keeping it at an angle of 40^0- 50^0 with the surfaces. In welding if the rod is ahead of the flame, then it is called forward welding and if flame is ahead of rod it is called backward welding. Upto 6mm thick plates forward welding is recommended, and above 6 mm thick plates

backward welding is recommended. Apply flux repeatedly to facilitate the welding. To stop the flame, first close acetylene gas and then oxygen gas. Close the regulators on the cylinders.

9. Chip off the slag with the chipping hammer and wire brush.
10. Check the weld for soundness by observing the bead.

6. PRECAUTIONS.

1. Carry the cylinders in trolly.
2. Keep the cylinders upright.
3. Connect the black/green hose pipe to oxygen gas cylinder and red hose pipe to acetylene gas cylinder (identifications thin cylinder is oxygen cylinder and bulky cylinder is acetylene gas cylinder)
4. Clean the cylinder valves before fitting the regulators.
5. Adjust the pressure of the gases according to the thickness of the metals to be welded.
6. Select the proper size of the nozzle as per the thickness of the metals to be welded.
7. To start the flame, open acetylene gas control valve first.
8. To stop the flame, close the acetylene gas control valve first and then the oxygen gas control valve.
9. Chip off the slag compltely from the welded surfaces.
10. Keep the acetylene cylinder away from fire.

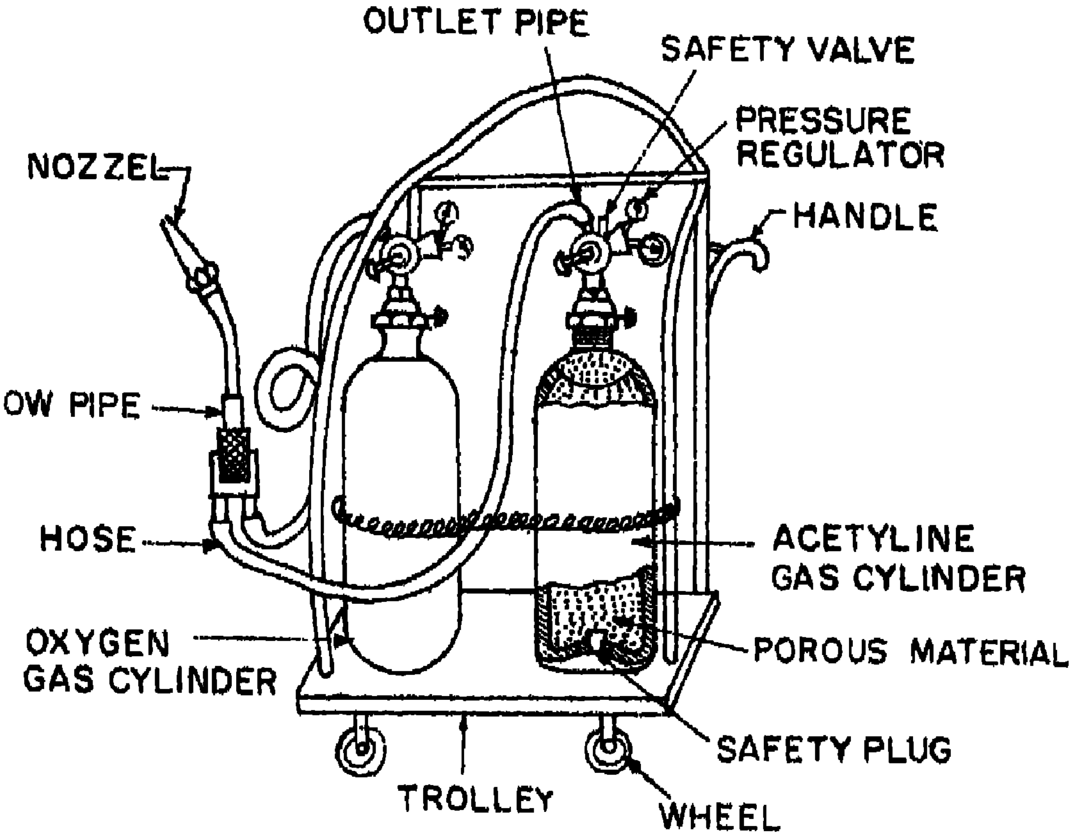
'. QUESTION FOR EVALUATION

1. In which case forward welding is recommended?
2. In which case backward welding is recommended?
3. What are the angles of blow pipe and the rod in forward as well as backward welding?

4. Is any flux recommended for welding mild steel?
5. What is the difference in welding, brazing and soldering?
6. How will you identify oxygen and acetylene gas cylinders?
7. How will you identify oxygen and acetylene gas cylinder regulators?
8. What are the correct methods of starting and closing the flame?

References:

1. Workshop Technology by Raghuwanshi.
2. Workshop Technology Pt. I by W. A. S. Chapman.
3. Workshop Practice by E. PULL.



.GAS WELDING SET
Fig. 3.1

EXPERIMENT/PRACTICAL NO.4

TITLE OF EXPERIMENT/PRACTICAL

Marking of pole and tower positions using chain surveying.

SPECIFIC OBJECTIVE

To acquire the skill of marking positions of poles and towers with the help of chain-surveying.

INTRODUCTORY INFORMATION AND RELATED THEORY

(i) Information

Surveying is the art of determining the relative positions of points on the surface of the earth by direct or indirect measurement of distance direction and elevation. In chain surveying only linear measurements are made in the field. The survey of the O.H. lines must be carried out very accurately. A mistake in the field or subsequent office work may pass undetected to an advanced stage of construction thus causing unnecessary expenditure and inconvenience. It is therefore essential that every care should be taken in setting out levelling and plotting profile of the route.

Survey of the O.H. line can be divided into two heads.

A. Preliminary walk over survey.

B. Detailed survey.

A. PRELIMINARY WALK OVER SURVEY

This survey is done by walking over the proposed route. If the line is very near to the road, this can be done by vehicle also. The purpose of the survey is to detect special locations of the route such as turning points, crossing of railway lines, rivers, canals etc. A rough map of the route is thus got prepared by this survey.

Detailed survey.

This is conducted with the help of the theodolite, dumpy level, levelling staff and chain. The selection of a particular method will depend upon type of land, availability of instruments and length of line.

While selecting the route for the lines the following points should be given due consideration.

1. The existing line should be nearest to the new line.
2. Route should be as short as possible and should be free from obstacles like telephone lines, railway lines, hills, valleys etc.
3. Line should be straight as far as possible.
4. Line should be near the main road to facilitate the transportation of the material and inspection.

EQUIPMENT AND MATERIALS

1. Chain 20 meter
2. Staff
3. Ranging rods with flags
4. Rough sketch of the route.
5. Wooden pegs
6. Hammer.
7. Tape 10 to 20 meter long

PROCEDURE

1. Based on the preliminary survey, put the flags at specific locations on the route, particularly where the line changes in direction.
2. Mark the approximate position of the intermediate poles.
3. One man will stand near the first flag and hold one end of the chain and the second man will move with free end of the chain towards the second flag and will stop at a place where one span is completed.

The first man will see that all the three flags are in XXx one line. Now the second man will fix his flag on the ground. In place of this flag first pole will be erected.

5. Following the same procedure pegs are fixed for the positions of the other poles.

6. PRECAUTIONS:

1. The alignment of the flags should be properly checked.
2. The chain should not be let loose while carrying out the survey.
3. Flags should be properly fixed so that they are not disturbed.

7. QUESTIONS FOR EVALUATION:

1. What is the necessity of the survey?
2. What are the various methods used for survey of the line routes?
3. Why alignment of poles is necessary?
4. How would you record the reult of the survey?

Reference:

Surveying Vol.I
Bu
Dr. B.C. Punmia.

EXPERIMENT/PRACTICAL NO.5

1. TITLE OF EXPERIMENT/PRACTICAL

Study of different types of fuses.

2. SPECIFIC OBJECTIVE

To study different types of fuses such as primary cut-out, cartridge fuse, kit-kat fuse, HRC fuse. High voltage fuse.

3. INTRODUCTORY INFORMATION AND RELATED THEORY

A fuse is a simple protective device which consists of a thin piece of metal wire which opens the circuit in which it is inserted, by melting when current through it exceeds a certain value.

This it prevents over-heating of electrical appliances. Its performance is simple. Materials which can be used as fuse wire are tin, lead, silver, tinned, copper, lead-tin alloy aluminium etc. A fuse has inverse line, Characteristic i.e. time of fusing decreases as current increase.

4. EQUIPMENT AND MATERIALS

i. Different types of fuses (Rewirable type and cartridge type)
ii. Screw driver
iii. Line-tester
iv. Test-board
v. Cutting plier

5. PROCEDURE (STUDY)

A. 1. Take rewirable type fuses such as kit-kat.

Remove the fuse wire from fuse carrier with screw driver. and study it. (open type and semi-enclosetype)

2. Factors on which current carrying capacity of a fuse wire depends are:

(i) Type of material used.

(ii) The cross-sectional area i.e. circular of rectangular.

(iii) Length of fuse wire used.

(iv) Surroundings.

3. Draw the figures of open type and semi enclosed type rewirable fuses (Refer fig.5.1)

4. Construction of Rewirable type fuses.

It consists of two parts(i) Fuse base. An ASBESTOS tube is fitted in the fuse carrier. The fuse wire is passed through this tube and is connected to contacts. After fitting the fuse wire, fuse carrier is fitted into fuse base. The circuit wires are connected to the fuse base contacts. Due to simplicity and cheapness, the rewirable type fuses and extensively used as protective devices on low and medium voltage circuits.

5, Disadvantages of Rewirable type fuses.

(i) Oxidation of fuse wire and consequent thinning of wire section with laps of time.

(ii) Local heating caused by loose connections.

(iii) Due to small time lag, these fuses can blow with large transit currents which are encountered during starting of motors etc.

(iv) More often than not, any available piece of wire is inserted as a fuse wire inserted of proper fuse wire.

(v) These fuses have low reputuring capacity.

B. 1. Take cartridge type fuses.

These fuses are also called high repturing ~~capacity~~ (H R C) fuses.

2. Draw the figure of a cartridge type fuses. (Refer fig.5.2)

3. Construction

The body of the cartridge type fuses is made of ceramic and is provided with metallic caps (brass). The fuse element is attached between the two end caps. The cylindrical body of the fuse is filled with a filling powder.

4. Working : When the fuse is carrying normal rated current, the temperature of the fuse element does not reach melting point. When a fault occurs, the fuse element melts before the fault current reaches its first peak. As the heat is produced, the melted fuse element will vapourise. The filling powder is of such a quality that the chemical reaction between silver vapour and filling powder forms a high resistance substance which very much helps in quenching the arc. In general quartz sand is used as a filler because it can absorb heat at higher rate.

Advantages.

(i) Simple and easy installation
(ii) High-breaking capacity.
(iii) No maintenance.
(iv) Extreme reliability.
(v) Non-deterioration for long period.
(vi) Closer control on sustained over-loads.

High Voltage fuses. H.V. expulsion type fuses are used extensively for protection of feeders and transformers because of their low cost. These fuses are operated Gang Operating Switch (G.O.S) from the ground. When a fuse blows off, it drops down and can be easily seen.

Selection of fuses: The following points should be considered while selecting fuses:-

1. It should not operate under conditions of momentry over load and during starting operations.
2. It must operate when sustained over load or short circuit occurs.

6. PRECAUTIONS

1. Select the fuse according to the current rating.
2. While replacing the fuse, first switch off the line.
3. Use correct gauge and material of fuse wire while replacing the blown-off fuse.
4. Fuse kit-kat or cartridge should be firm in its position.

7. QUESTIONS FOR EVALUATION

(i) What is the function of a fuse in an electric circuit?

(ii) Why is current rating important in selection of a fuse wire?

(iii) What will happen if wrong gauge or wrong material fuse wire is used?

(iv) Cartridge fuses are preferred to rewirable fuses? Why?

(v) How oxidation spoils a fuse wire?

Note: - Different types of fuses in common use must be collected and shown to the lineman)

References

1. A Hand Book of Electrical Engineering by S.L. Bhatia.
2. Electrical Power by J.B. Gupta.

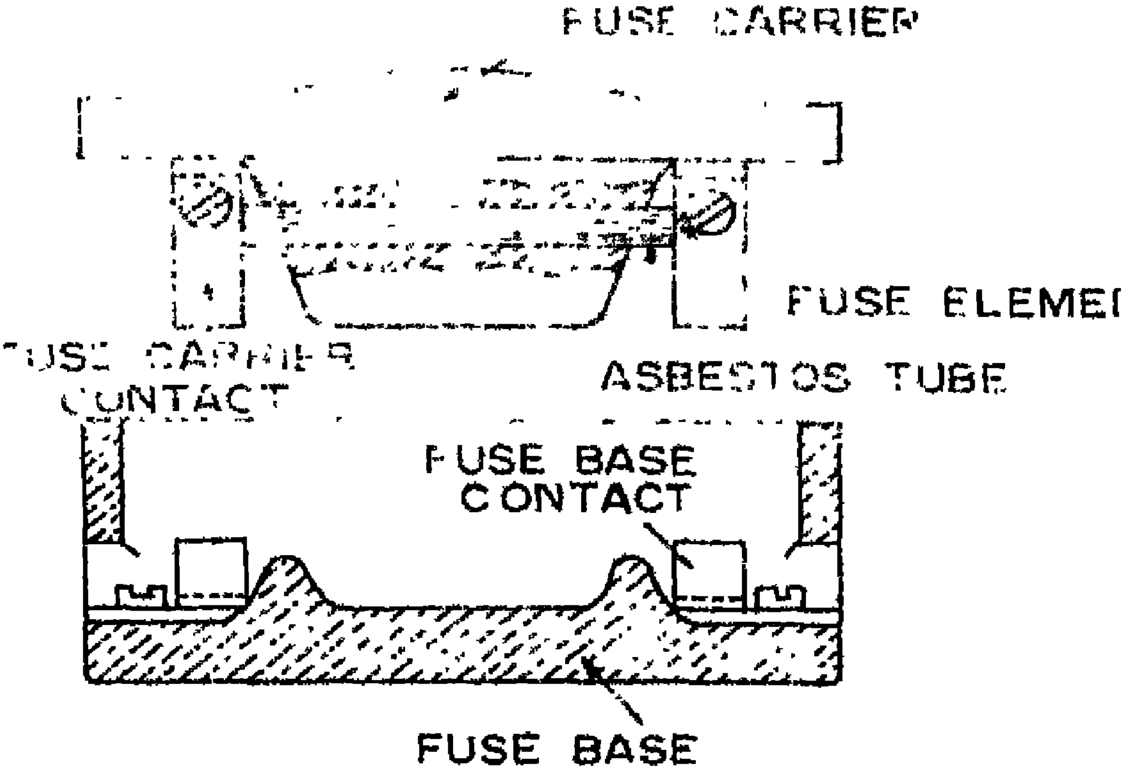
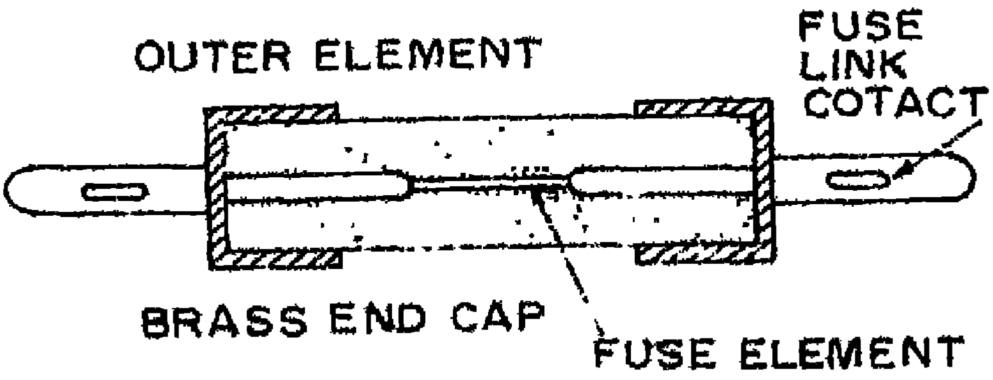


Fig 5·1



SEMI–ENCLOSED REWIRABLE FUSE

Fig.5·2

EXPRIMENT/PRACTICAL No.6

1. **TITLE OF EXPERIMENT/PRACTICAL**

Study of different types of wires and cables.

2. **SPECIFIC OBJECTIVE**

To acquaint the lineman with different types of wires and cables.

3. **INTRODUCTORY INFORMATION AND RELATED THEORY**

The lineman is required to use wires and cables in his day-today work. He should, therefore, be able to select required type of wire/cable for the specific job.

Wire is a piece of insulated or un-insulated circular conductory, uniform in diameter. Cable is a length of one or more than one insulated conductor which are laid up together. Cables are known as single core, twin core, or three-core accordingly as there are one, two or three conductors. Conductors are generally made of copper and aluminium. Copper though very good conductor is sparingly used as it is costly. In contrast, aluminium having its conductivity 60% as that of copper are extensively used because of its cheapness and light weight.

STRANDED WIRES

The wires used for ordinary wiring purposes may be single solid conductors, but when the wires are required for greater flexibility, these are stranded. The number of conductors stranded together depends upon the current carrying capacity of the wire.

TYPES OF WIRES

The wires used for general electrical purposes can be divided into the following:

1. Lead alloy sheathed wires.
2. Tough rubber sheathed (T.R.S.) or C.T.S. (Cab.tyre sheathed)

3. Weather proof wires

4. Flexible wires

5. Poly Vinyl Chloride (P.V.C.) wires.

6. VIR wires (Vulcanised India Rubber)

i) Lead Alloy sheathed wires

Such types are recommended where the climatic condition is not dry, but has some moisture. These are available in the following types:-

i. Single core lead-sheathed

ii. Flat twin lead alloy sheathed

iii. Flat lead alloy sheathed with E.C.C.
(earth continuity conductor)

The lead covering is usually thin and provide only a little mechanical protection. Fig 6.1 shows a Flat twin lead alloy sheathed wire.

2. Tough Rubber Sheathed (T.R.S.) or Cab Tyres sheathed (C.T.S.) wires.

These cables are costlier and are quite heavy in weight. The T.R.S Cables have properties similar to that of lead sheathed cables. The ordinary wire is provided with other insulation which is not water-resistant, but the T.R.S. wires are provided with a tough rubber compound and can stand long exposure to moisture and can be used in wet climate.
(Fig 6.2 a,b shows in a single core and twin core wires)

3. WEATHER PROOF WIRE

These are for outdoor purposes i.e. these are run between buildings. These wires consist of 3 braids of fiber yarn provided over the copper conductors. The copper conductors are not usually tinned. Before these braids are applied they are thoroughly saturated with a water-proof compound. Fig. 6.3

FLEXIBLE WIRES

The wires used for household appliances such as heaters, irons, refrigerators etc. must be durable and very flexible. These usually consists of two separately insulated flexible stranded conductors. These wires are further classified as (a) Twin silk cord (b) Twin Rubber-insulated cord. (c) Twin twisted cotton Braided Flexible wire and (d) Twin T.R.S. Flexible wire.

Twin silk cord consists of two cores each consisting of number of fine copper conductors, stranded together. Each conductor is covered with cotton then with rubber and then both the conductors are covered with silk insulation FIG.6.4 a

Twin Rubber- insulated cord is similar to that twin silk cord wire and consists of two stranded conductors each covered with cotton and embeded in the solid mass of rubber insulation. The rubber used for the purpose is of quality. Fig.6.4 b.

Twin twisted cotton braided flexible wires are insulated like silk flexible cord and are followed up with a layer of rubber insulation and then braided with cotton. Then two of these type conductors are twisted together. Fig.6.4 c

The T.R.S. flexible wires consists of two or more insulated conductors twisted together as in the case of twin twisted flexible wire. The open space in-between the twisted conductors is filled-up with cotton or jute threads so as to form a round assembly. Over this assembly is provided a loose cotton braid and then a final layer or high grade tough rubber. See Fig 6.4 d.

(v) PVC Insulated wires

These wires are available in 250/440 and 650/1100

volts grades and are used in concealed wiring system. In this type of wire, conductor is insulated with PVC insulation. Since PVC is harder than rubber as such these do not require cotton tapping and braiding over PVC insulation for mechanic and moisture protection.

CABLES.

The power from the generating stations can be transmitted either by overhead lines or by cables placed underground. The cables are usually classified according to the voltage for which they are manufactured.

(i) L.T.C. (low tension cables) upto 1000 volts.

(ii) H.T. (high tension cables) upto 11,000 volts.

(iii) S.T.C. (super tension cables) from 22,000 volts to 33,000 volts.

(iv) Extra high tension cables from 33,000 volts to 66,000 volts.

(v) Oil filled and pressure and gas pressure cables from 66,000 volts to 1,32,000 volts.

GENERAL CONSTRUCTION

(a) Core : All cables have one central core, or a number of cores, of straindeded copper conductors having highest conductivity. In general, there are one, two , three or four cores.

(b) Insulation: The different insulations used to insulate the conductors are paper, varnished cambric and vulcanized bitumen for low voltage. Mostly impregnated paper is used which is an excellent insulating material. For low voltage cables, petroleum jelly is applied between the layers of the cambric tape which prevents damage to the insulating tape due to friction when the cables are handled.

(c) Metallic sheath: It is provided over the insulation so as to prevent the entry of moisture into the insulating material.

(c) Bedding: It consists of paper tape compounded with a fibrous material. The purpose of bedding is to protect the metallic sheath from mechanical injury.

(d) Armouring:- It is provided to avoid mechanical injury to the cable and consists of one or two layers of galvanised steel wires or two layers of steel tape.

(f) Serving:- Over and above armouring, fibrous material is again provided which is similar to that of bedding but is called as serving.

Types of 3-Phase Cables.

(a) Belted cables.

Fig.6.5 represents the 3-core belted cables in which case each of the conductor is insulated from the other with impregnated paper. Surrounding the three conductors is again provided with a belt of paper and interstices between them is filled with insulated material.

(b) H-type cables. This cable has no belt insulation, but each of the conductors is insulated with paper to the desired thickness and over this is provided a layer of metallised paper perforated to facilitate the process of impregnation. The fibrous material in the center and along the filler spaces gives the round shape to the cable. Over this comes the copper woven tape so that the lead sheath, the binder of the metallized foil, are all at earth ptential. The layers of braiding, armouring and serving are provided as in the previous case. See Fig.6.6

S.L. Cable: (See Fig. 6.7)

In this case the individual conductors are first insulated with impregnated paper and are covered with

a metallic sheath after which they are laid up and armoured.

(d) H.S.L.Cables (See Fig.6.8)

Such a cable is a combination of H-Type and S.L. type cables in which case each conductor is insulated sheathed with metallized paper and is then lead sheathed. The three cores are then laid up and provided with filler, braided, armoured and finally served.

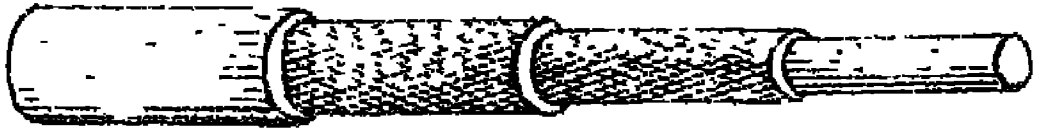
QUESTION FOR EVALUATION

1. What is the difference between wire and cable?
2. What are the various conducting materials used in cable?
3. What are the essential properties, which insulations used in cable must have?
4. What are the insulating materials those are used in cables?
5. Name the various types of wires and cables usually employed in internal wiring of building?
6. Why multi-strand conductors are preferred to the single solid conductors?
7. How the size of the wire specified?
8. What do you understand by voltage grading of cable?
9. How the cables are specified?

References:

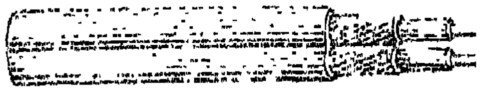
1. A Hand Book of Elect. Engg. by S.L. Bhatia.
2. Electrical Wiring, Estimating and costing by S.L. Uppal.

Fig. 6.2



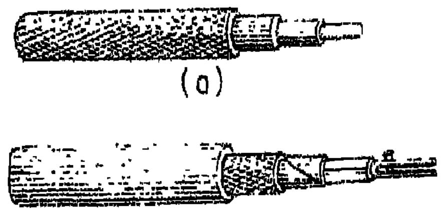
WEATHER-PROOF WIRE

Fig. 6.3



LEAD ALLOY SHEATHED

Fig 61



(a)

(b)

THOUGH RUBBER SHEATHED (T.P.S.

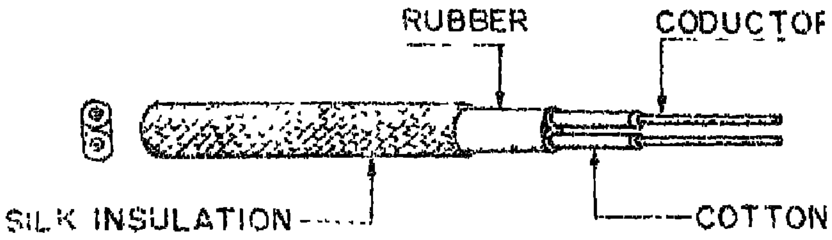


Fig.6 4a

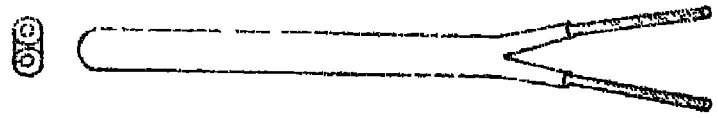
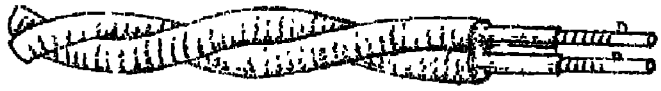
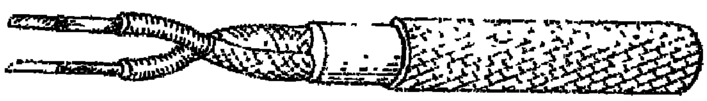


Fig.6.4b



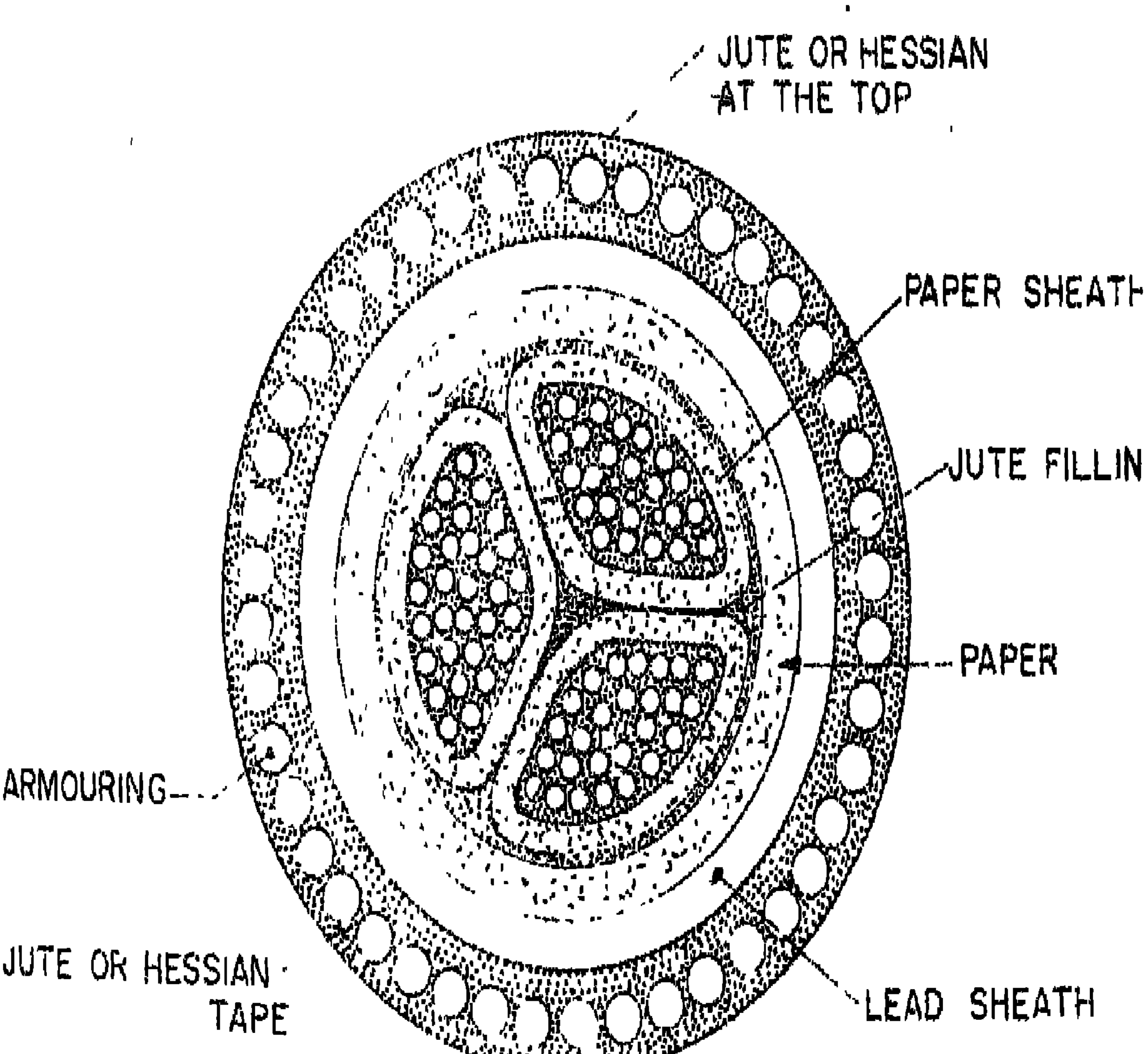
TWIN TWISTED COTTON BRAIDED FLEXIBLE WIRE

Fig.6.4c



TWIN FLEXIBLE WIRE

Fig.6.4d



BELTED TYPE CABLE

Fig 6.5

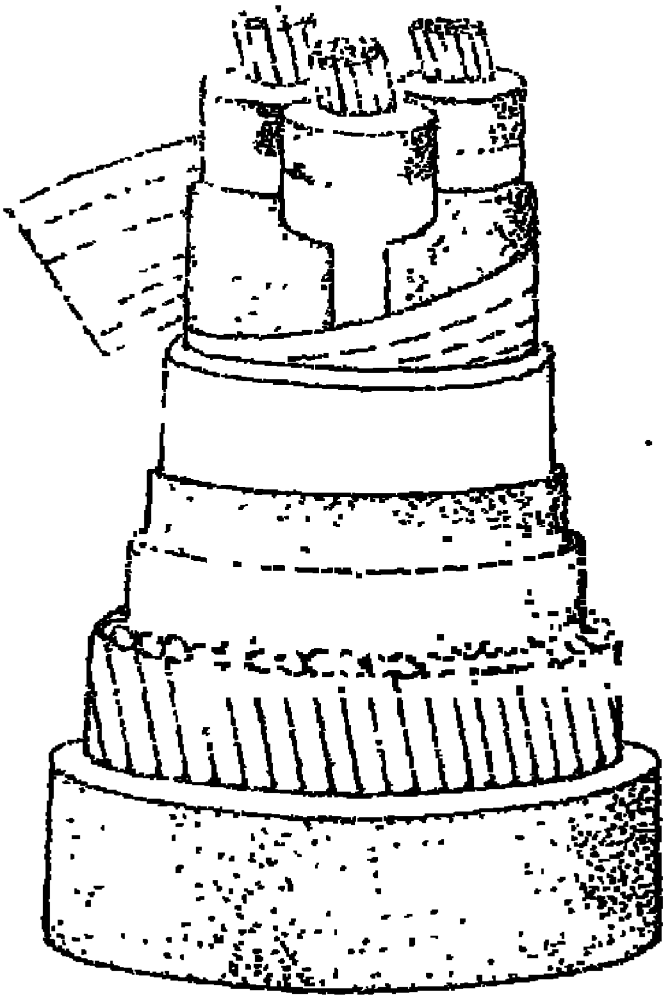
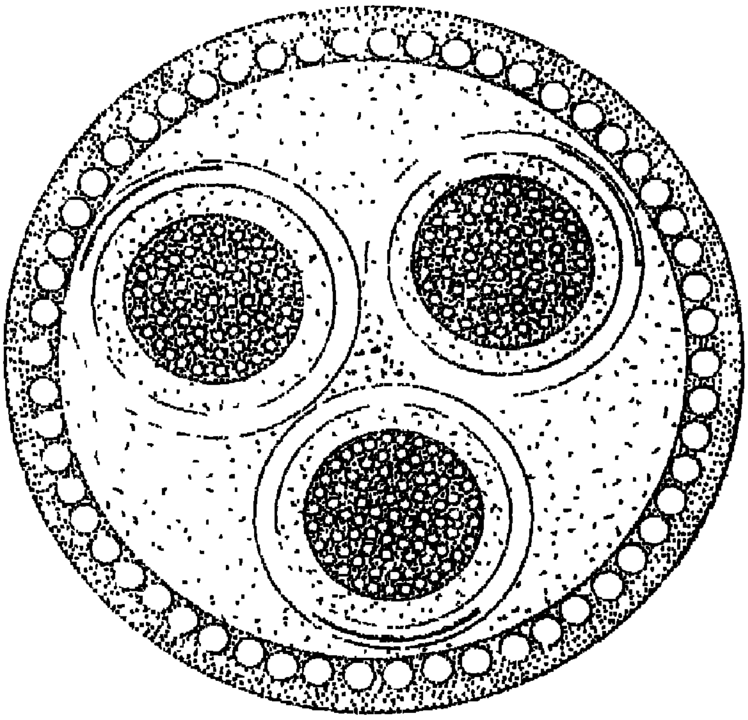


Fig. 6.6



SL TYPE CABLE (33KV THREE CORE)

Fig. 6.7

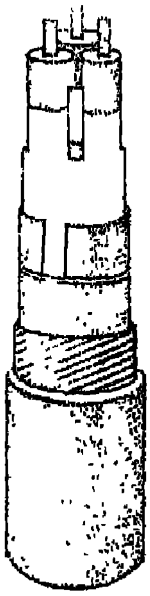


Fig.6.8

EXPERIMENT/PRACTICAL No.7

1. TITLE OF EXPERIMENT/PRACTICAL

A study of different types of insulators.

2. SPECIFIC OBJECTIVES

To acquaint the lineman with the different types of insulators and their use in overhead lines.

3. INTRODUCTORY INFORMATION RELATED THEORY

(a) Introductory information·

Different types of insulators are used in overhead line for supporting the conductors, so that conductors are insulated, (electrically) from other mettallic parts of line.

RELATED THEORY

Different type of insulators are available for use on different voltages. The materials used for insulators are either porcelain or glass.

The different types of inslators are as under:-

1. Pin type
2. Suspension type
3. Shackle insulator
4. Strain insulators
5. Egg · insulator
6. Post insulators (used for supporting bus bars)

Pin type insulators are used upto 33 KV line and each unit of pin type is designed for 12 KV. For voltages above 33 KV, suspension type insulators are used, Each disc of suspension type of insulators is of 11 KV. Shackle Insulators are used in medium line for dead ends and turning points for supporting conductors. Egg insulators are used in stay wire to avoid leakage of current in lower part of stay.

The strain insulators are used at and turning points in H.T. line.

4. EQUIPMENT AND MATERIALS:

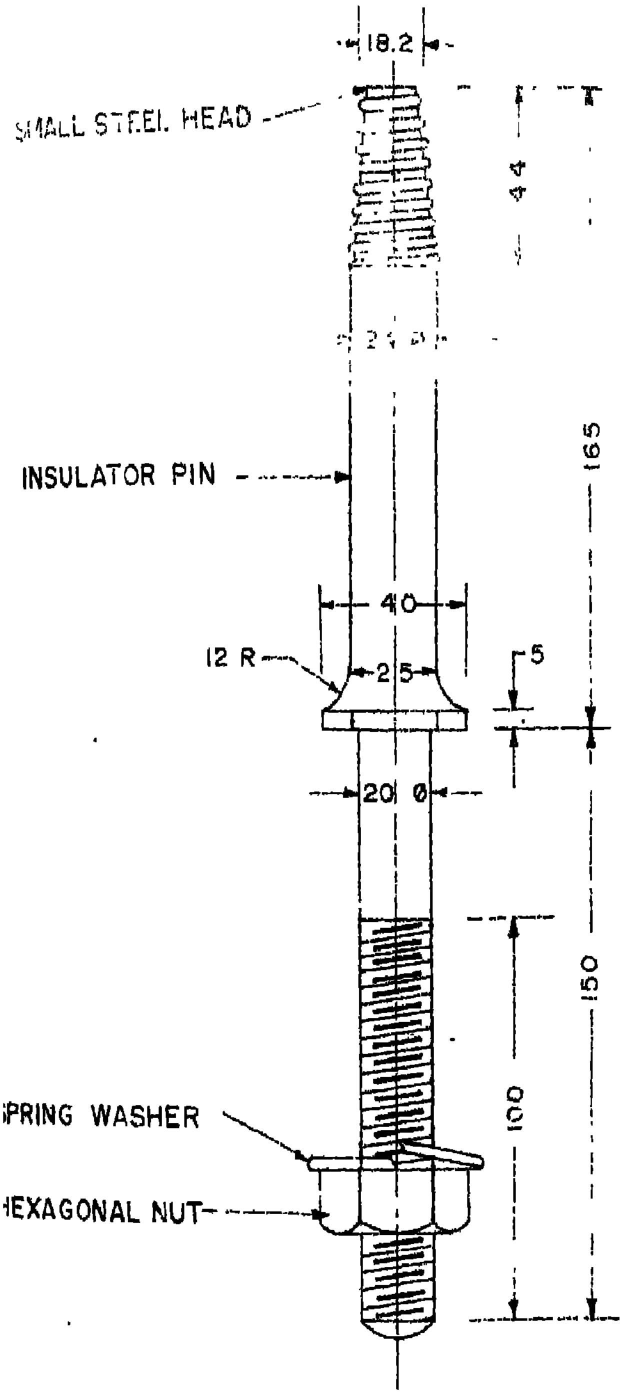
Different types of Insulaters attached. (fig.7.1 to 7.5)

5. QUESTIONS FOR EVALUATION

1. What are different types of materials used for making insulators?
2. Why suspension [illegible] insulators are used for [illegible]
3. Name the various types of insulators?
4. Where strain insulators are used?
5. Upto what maximum voltage, pin type insulators are used?
6. When do we use egg insulators?
7. What is the voltage of each disc of suspension insulator?
8. Why the use of pin type insulators is not recommended beyond 33 KV?

Reference:

1. A Hand Book of Electrical Engg. by S.L. Bhatia.
2. Electrical Power by J.B. Gupta



NOTES

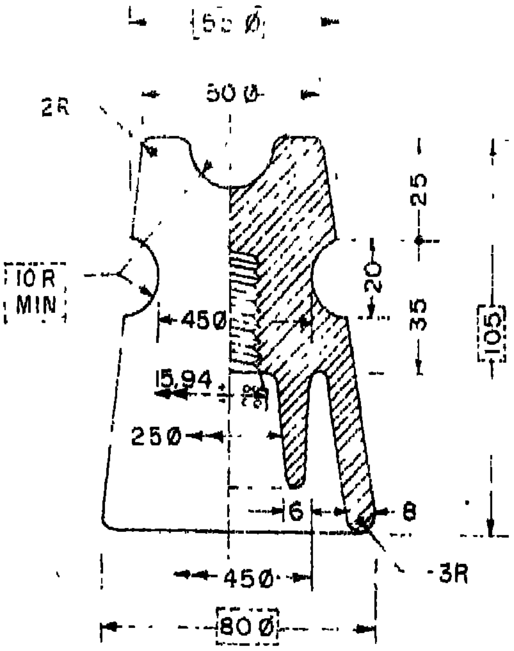
1. PIN IS SHOWN SUITABLE FOR METAL CROSS ARM
2. FOR WOOD CROSS ARM INSTEAD OF SPRING WASHER, USE TWO SQUARE WASHERS 50X50X5 mm ONE ON TOP AND THE OTHER AT BOTTOM

ALL DIMENSIONS IN mm
UNLESS OTHERWISE INDICATED

11 KV INSULATORS & FITTING
INSULATOR PIN

SCALE = 1/2 FULL SIZE

Fig. 71



NOTES :-

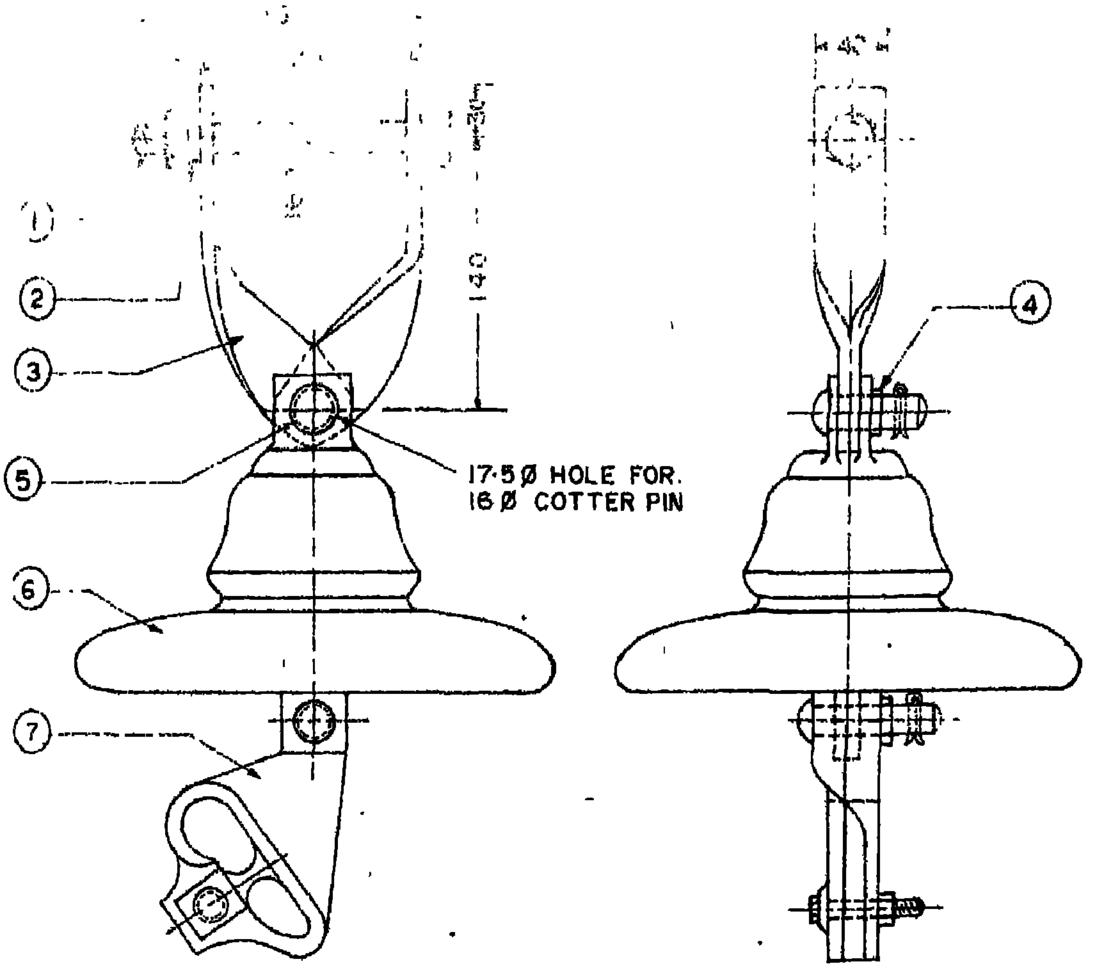
1. THE UPPER GROOVE OF THE PIN INSULATORS SHOULD BE SLIGHTLY SLANTING SO THAT THE POSSIBILITY OF DAMAGE TO THE CONDUCTOR ON THE SHARP EDGES IS AVOIDED
2. THE ENCLOSED DIMENSIONS ARE MANDATORY. OTHER DIMENSIONS AND THE PROFILE ARE GIVEN FOR GUIDANCE

ALL DIMENSIONS IN mm
UNLESS OTHERWISE INDICATED

415/240V INSULATORS & FITTINGS
PIN INSULATOR

SCALE 1:2 FULL SIZE

Fig 7·2



ELEVATION

END-VIEW

BILL OF MATERIAL

1	BOLT-NUT -16 Ø X 145 —	1
2	SPRING WASHER — —	1
3	CROSS-ARMSTRAPS —	2
4	WASHER — — — —	2
5	COTTER PIN — — — —	2
6	DISC INSULATOR — — —	1
7	CLEVIS ENDED CLAMP WITH ALUMINIUM LINER — —	1

ALL DIMENSIONS IN mm
UNLESS OTHERWISE INDICATED

11 KV INSULATORS & FITTINGS
CLEVIS AND TONGUE TYPE
STRAIN INSULATOR SET

R
SCALE — NTS

Fig. 7.3

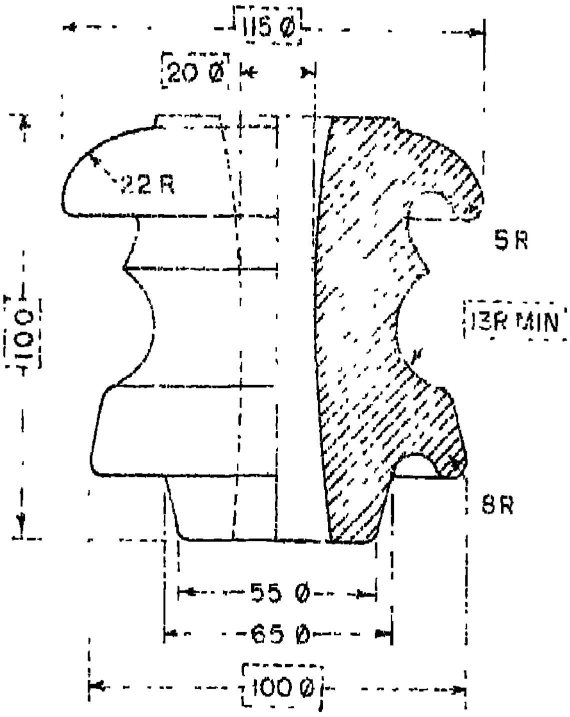


Fig. 7.

NOTE. THE ENCLOSED DIMENSIONS
ARE MANDATORY. OTHER
DIMENSIONS AND THE PROFILE
ARE GIVEN FOR GUIDANCE

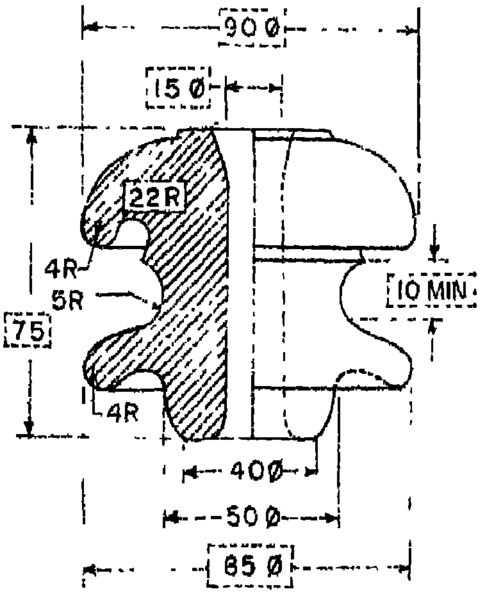


Fig. 7.

ALL DIMENSIONS IN M.M.

415/240 VOLTS
SHACKLE INSULATORS

SCALE:- N.T.S.

EXPERIMENT/PRACTICAL NO.8

1. **TITLE OF EXPERIMENT/PRACTICAL**

Practice of mounting different types of insulators on O/H lines.

2. **SPECIFIC OBJECTIVE**

To acquire skill to mount different types of insulators on O/H lines.

3. **INTRODUCTORY INFORMATION AND RELATED THEORY**

The main function of the insulator is to insulate the electrical conductor from pole and other metallic parts of the overhead lines and to support the conductor. Various types of insulators are used for different voltages as per I.S.I. Code IS:1445-1966.

4. **To mount Pin type Insulators on O/H Lines**

4. **EQUIPMENT AND MATERIAL:**

(i) Poles duly fitted with cross-arm
(ii) Pin type insulators
(iii) Spanner set
(iv) Ladder
(v) Line Rope
(vi) Safety belt

5. **PROCEDURE**

(i) Keep all the necessary materials and tools near the pole, on which the pin insulators are to be mounted.

(ii) Climb on the pole with the help of the ladder to the height of x-arm, and use safety bolt.

(iii) Take out the pins from the insulator and put the pins in the holes of the cross arm and tighten the nut of the pin firmly with cross arm.

(iv) Fix the insulators on the pin as shown in fig.8.1

B. To mount shackle insulators on O/H lines.

4. EQUIPMENT AND MATERIAL

i. Poles duly fitted with cross arms

ii. Shackle type insulators

iii. U-clamp with two m.s. bolts.

or

Two straps with two m.s. bolts.

iv. Spanner set

v. Ladder

vi. Safety belts.

vii. Line rope.

5. PROCEDURE

i. Keep all the necessary materials and tools near the poles on which the shackle insulators are to be fitted.

ii. Climb on the pole with the help of the ladder to the height of cross arms. Use safety belt.

iii. Fix the insulators on the pole as shown in fig.8.2.

C. To mount suspension type insulators on lines.

4. EQUIPMENT AND MATERIAL

1) Poles duly fitted with cross-arms

ii) Suspension type (Disc type) insulators complete with fittings.

iii) Spanner Set (Open-ended)

iv) Ladder of proper height

v) Line rope.

5. PROCEDURE

i. Keep all the necessary materials and tools near the poles on which the insulators are required to be fitted.

ii. Climb on the pole with the help of the ladder to the height of corss-arms. Use safety belt.

iii. Use cotter pin for holding the tongue of the unit

in the clevis of the other if the insulators are of tongue clevis type. Slide the ball of one insulator into the socket of next insulator from the side, if the insulators are of ball and socket system by slipping of cotter pin from the back of socket.

iv. In case of very long span use two or more string assemblies in parallel as per the requirement.

v. Fig. 8.3 shows a disc insulator string assembly.

6. PRECAUTIONS

i. Do not work without safety belt.

ii. Carry the correct type of spanner set.

iii. To raise & lower the material, tools etc., use line rope extensively.

iv. Ladder should be held properly against the pole.

7. QUESTIONS FOR EVALUATION

i. How line rope is operated ?

ii. Why the use of a safety belt is a must while working on the pole.

iii. Why more than one strings are used in some cases ?

iv. How the locking of ball & socket type insulator is done ?

v. Out of the tongued & clevis type and ball and socket type insulators, which are more convenient to use and why ?

vi. Why the pins of pin insulators are galvanised ?

vii. How will you disinguish the correct position of shackle insulators ?

REFERENCES

1. A Hand book of Electrical Engineering by S.L. Bhatia.

Fig. 8.1

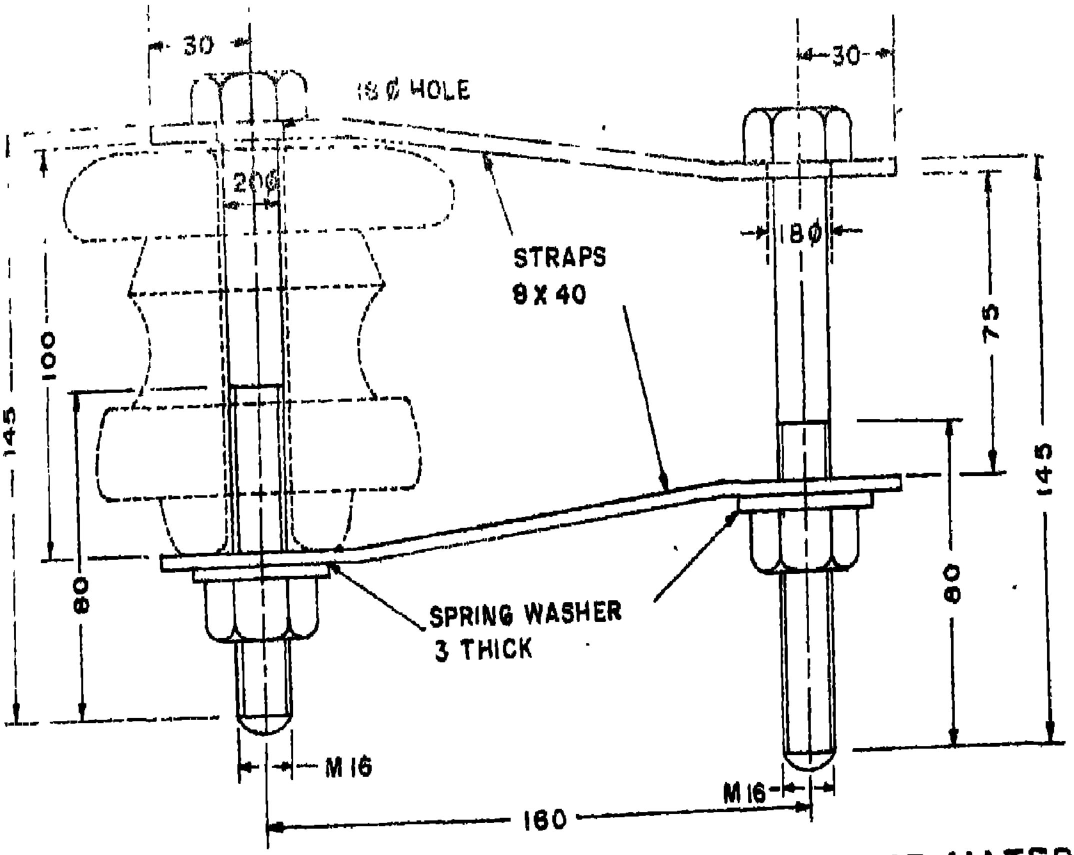
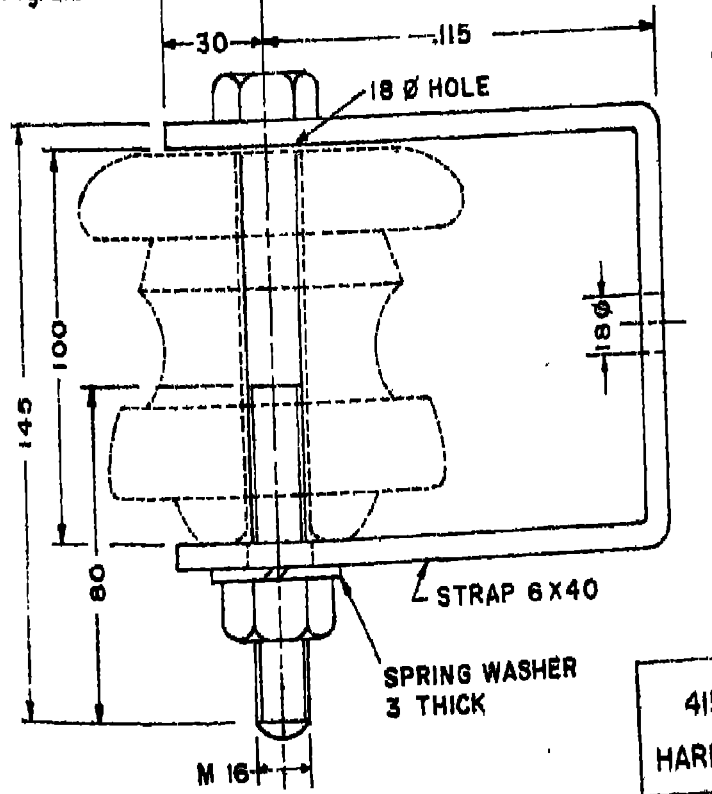


Fig.8.2



BILL OF MATERIAL

	STRAP TYPE FITTING	
1	STRAP -- 40 X 8	2
2	BOLT --- 160 X 145	2
3	SPRING WASHER-3 THICK	2
4	HEXAGONAL NUT	2
	U CLAMP FITTING	
1	STRAP --- 40 X 6	1
2	BOLT --- 160 X 145	1
3	SPRING WASHER - 3 THICK	1
4	HEXAGONAL NUT	1

415/240 V INSULATORS & FITTINGS
HARDWARE FOR TYPE SHACKLE INSULATOR

SCALE:— ½ FULL SIZE

EXPERIMENT PRACTICAL NO.9

1. **TITLE OF EXPERIMENT/PRACTICAL**

   Binding of conductors.

2. **SPECIFIC OBJECTIVE**

   To acquire the skill of binding the conductors with insulators.

3. **INTRODUCTORY INFORMATION AND RELATED THEORY**

   To secure the conductors with insulator so that it is not disturbed from its position due to pulling of conductors or natural calamities like storms, wind, rains, etc., binding of conductors with the insulators is essential.

   Now a days all aluminium conductors (AAC) and Aluminium Conductors steel Reinforced (ACSR) Conductors are used as line conductors.

   RELATED THEORY

   . Aluminium conductors need reinforcement at all points of support and dead ends to prevent conductor breakage by fatigue and vibration. The reinforcement is provided by using annealed aluminium tapes or wires. The aluminium tapes are generally used for short spans in urban and rural distribution.

4. **EQUIPMENT AND MATERIALS**

   i. Insulators
   ii. Conductors
   iii. Ladder
   iv. Safety Belt
   v. Line rope
   vi. Cutting plier
   vii. Binding wire (annealed)
   viii. Binding tape (0.77mmx6.4 for small size conductor and 1.25 mm x 7.70 mm for bigger size conductor).

5. PROCEDURE

A. Binding of Conductor with Pin-insulator.

i. Mark the related length of the conductor and bind with binding tape.

ii. Wind the binding wire on either side from the center of the related length of the conductor.

iii. Place the conductor in the groove of the pin-insulator.

iv. Take around the binding wire of one end tightly on the side groove of the insulator in the clock-wise direction and finish the binding wire on the same side by winding it on the conductor.

v. Repeat step No.4 exactly for the other end of the binding wire giving a clock-wise turn on the side groove and finish off the binding on the opposite end of the conductor. (See Fig.No:9.1)

vi. [illegible]

B. Binding of conductor with shackle insulator

i. Take the conductor [illegible]ugh the shackle-insulator and pull it.

ii. Make the loop of the conductor around the shackle groove.

iii. Wind the binding wire around the lapped ends as shown in Fig.9.2

C. Clamping of conductor with suspension type (disc type). Insulator

i. Attach the clamp to the lowest disc of the disc type insulator using the pin.

ii. Insert the conductor in the groove of the clamp.

iii. Tighten the nuts of the clamps.

6. PRECAUTIONS

i. Wind the binding wire closely and tightly.

ii. Wind the binding wire in the direction of stranding of conductor.

iii. Binding wire should be of the same material as that of conductor.

iv. Position the conductor in the insulator groove correctly before binding/clamping.

v. Use safety measures while working.

7. QUESTION FOR EVALUATION

i. Why is the binding of conductors with the insulator necessary?

ii. Why is the same material used for the binding wire as well as conductor?

iii. What is the difference in the three methods of binding/clamping of conductors with insulators?

iv. What are the normal sizes of binding wire?

v. Why is it necessary to keep the same direction of winding of binding wire as that of the stranding of conductor?

References

1. A Hand Book of Electrical Engg. by S.L. Bhatia.

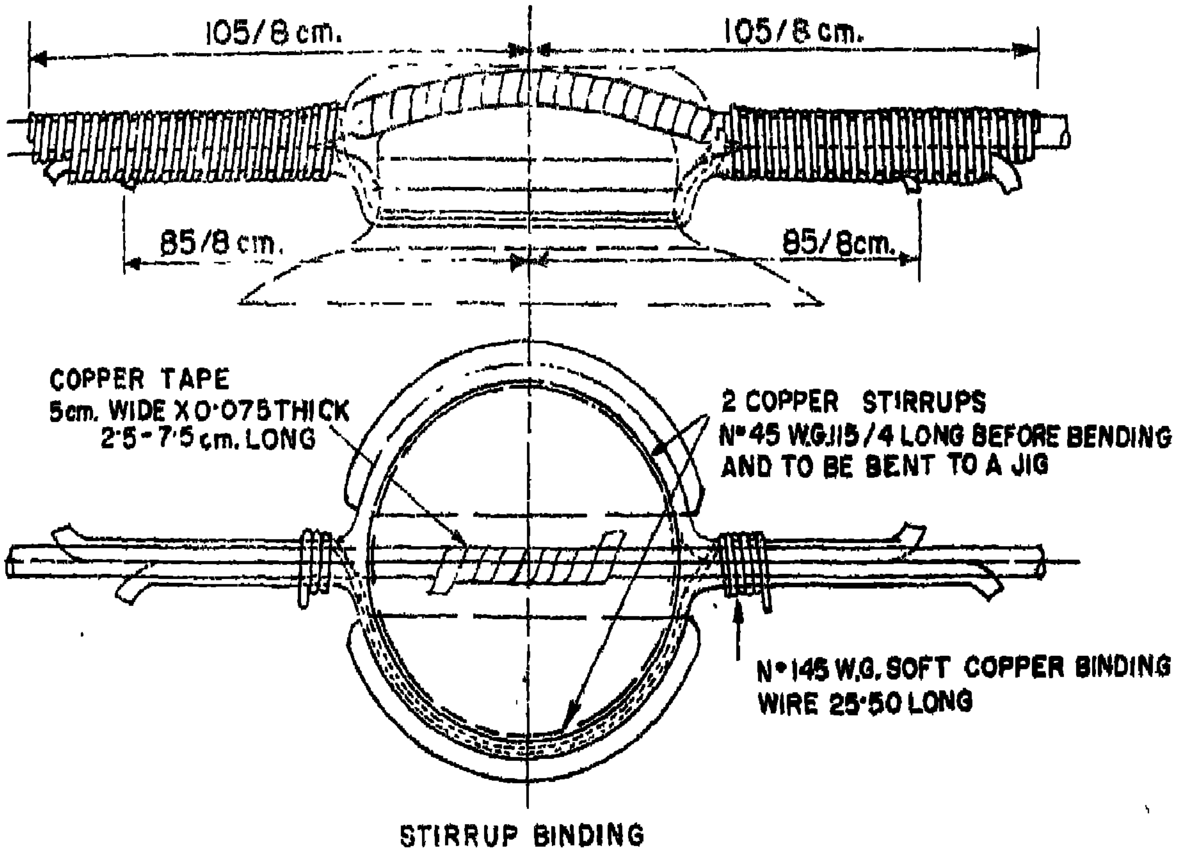

105/8 cm.
105/8 cm.
85/8 cm.
85/8cm.
COPPER TAPE
5cm. WIDE X 0·075 THICK
2·5 - 7·5 cm. LONG
2 COPPER STIRRUPS
N°45 W.G.115/4 LONG BEFORE BENDING
AND TO BE BENT TO A JIG
N°145 W.G. SOFT COPPER BINDING
WIRE 25·50 LONG
STIRRUP BINDING

Fig. 9.1

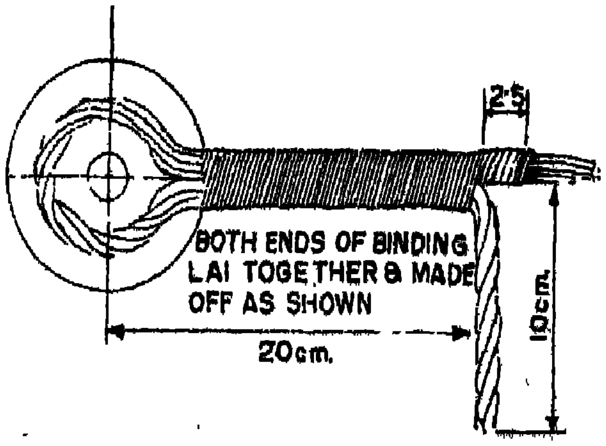

2·5
BOTH ENDS OF BINDING
LAI TOGETHER & MADE
OFF AS SHOWN
20cm.
10cm.

Fig 9.2

EXPERIMENT/PRACTICAL NO.10

1. TITLE OF EXPERIMENT/PRACTICAL NO.

Inspection of lines, tracing of circuit by visual observation and visual fault finding.

2. SPECIFIC OBJECTIVE

To acquaint a lineman with the purpose and schedules of inspection of lines and visual fault finding.

3. INTRODUCTORY INFORMATION AND RELATED THEORY.

1. Inspection signifies a visual check and tracing of lines without physically disassembling the lines while in service. Periodical inspection of lines while in operation provides a check on their conductors, reveals the fault and defects which may have developed while in operation and make it possible to take timely action.

2. All the electric lines are inspected before any maintenance work is carried on them. The inspection of lines is carried as follows:-

(a) Emergency Inspection:- When over overhead line trips on a sustained fault, it should be inspected to find out the nature of the fault such as snapping of conductors, tree branches touching the line, conductor failling on x-arm etc. The improvement with a view to avoid reoccurance of such fault in future should be arranged and carried out soon after.

(b) PREMONSOON INSPECTION

This inspection is carried out every year before the month of June by line staff. This inspection is carried out on all lines of 11 KV and above capacities so that there is no major

iii) Be alert so that no part of the body comes in contact with live wire.

iv) If tripping off line is necessary do not take risk to work on live line.

v) Do not touch a broken down live conductor, till you are assured that it is dead.

vi) Incase a broken live conductor is detected lying on ground, or in water or hanging in air, take necessary action to avoid accident to general public out of ignorance.

7. QUESTION FOR EVALUATION

i) Why the inspection of line is necessary?

ii) What is prescribed schedule for lineman for periodic inspection of lines?

iii) Why is it necessary to inspect line before or afte

monsoon season and winter season?

iv) What conditions may lead to arrange for immediate tripping off lines?

v) What immediate steps will you take if broken live conductor is detected lying on the ground?

References:

1. A Hand Book of Electrical Engg. by S.L. Bhatia.

EXPERIMENT/PRACTICAL NO.11

1. TITLE OF EXPERIMENT/PRACTICAL

Practice in preparing simple drawings showing layout of overhead lines (transmission lines).

2. SPECIFIC OBJECTIVE

To acquire the skill in drawing of O.H. Lines.

3. INTRODUCTORY INFORMATION AND RELATED THEORY

A lineman has to work for construction and maintenance of O.H. Lines, hence he must have the ability to sketch and read the drawing of these lines.

From voltage point of view the various lines are classified as -

Medium Voltage	440/230 V
High Voltage	3.3 KV to 33 KV
Extra High	Above 33 KV

The lines have various components as poles and towers, Cross arms, insulators, conductors and other accessories like binding wire, binding tape, P.G. clamp, joining and repair sleeves, arching horn, armour rods and ferrule, damper, tension and suspension clamps, anticlimbing devices, stays, guarding etc.

The layout of the lines must include all these components.

4. EQUIPMENT AND MATERIAL

i) Pencil and Rubber
ii) Drawing sheet
iii) Scale
iv) Compass

National Institute of Education
Library & Documentation
Unit (N.C.E.R.T.)
Acc. No F16070
Date 28/1/86

5. PROCEDURE

(i) Study the layouts of lines (Two number of drawings (11.1 and 11.2) of typical O.H. lines are enclosed.

(ii) Draw these layouts.

(iii) Have practice of drawing layout of any existing actual line (L.T. Line, H.T.Line and EHT Line)

6. PRECAUTION

(i) While preparing drawings of existing lines, all safety precautions should be taken.

(ii) While preparing drawings, use standard electrical symbols..

7. QUESTIONS FOR EVALUATION

(i) Why a lineman is required to have the practice of preparing drawings of O.H. lines?

(ii) Name various components of O/H lines.

(iii) What are the various categories of the lines on the basis of voltage?

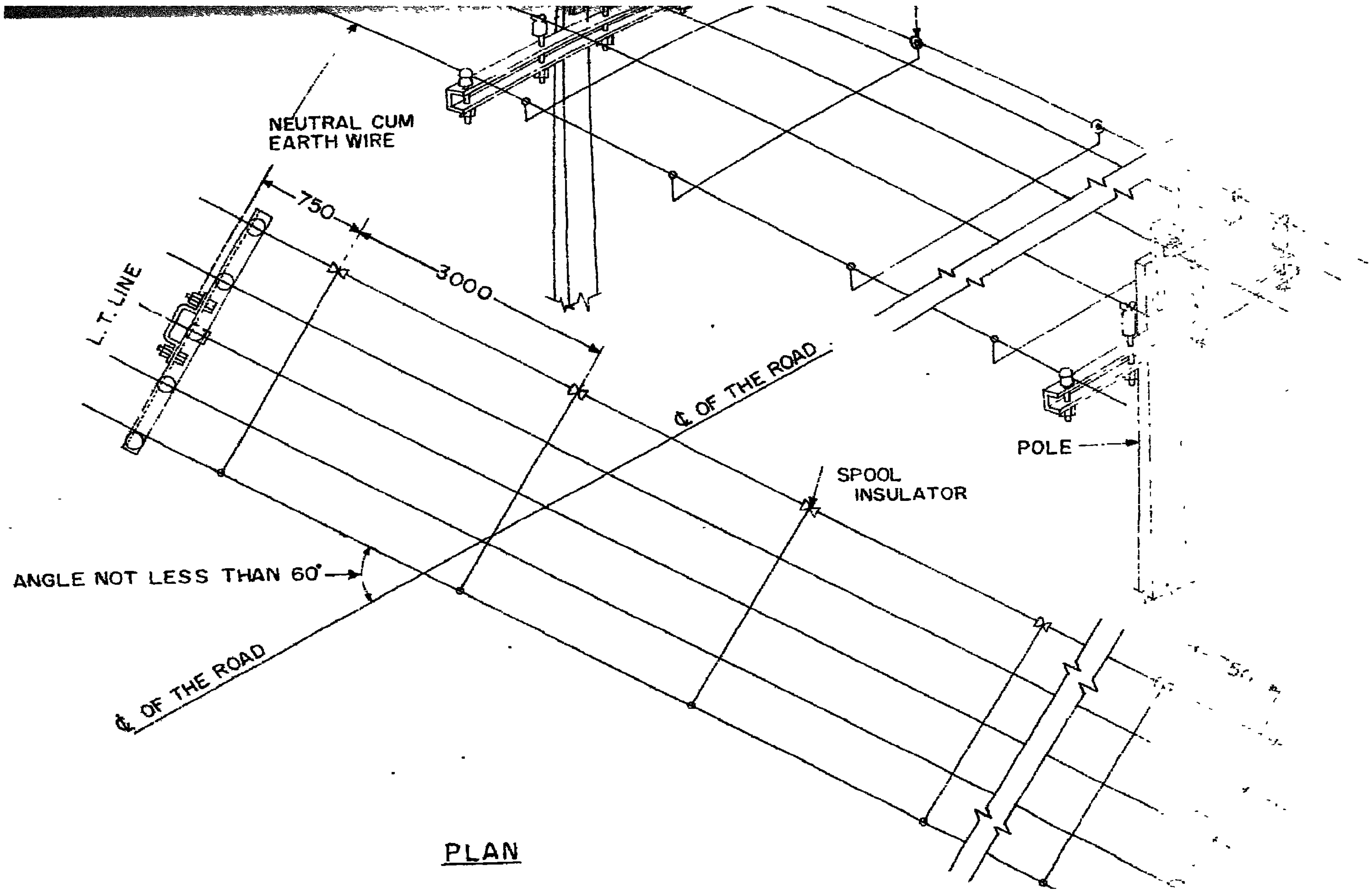
(iv) What precautions will you take while sketching the layout of an existing live O/H line?

References:

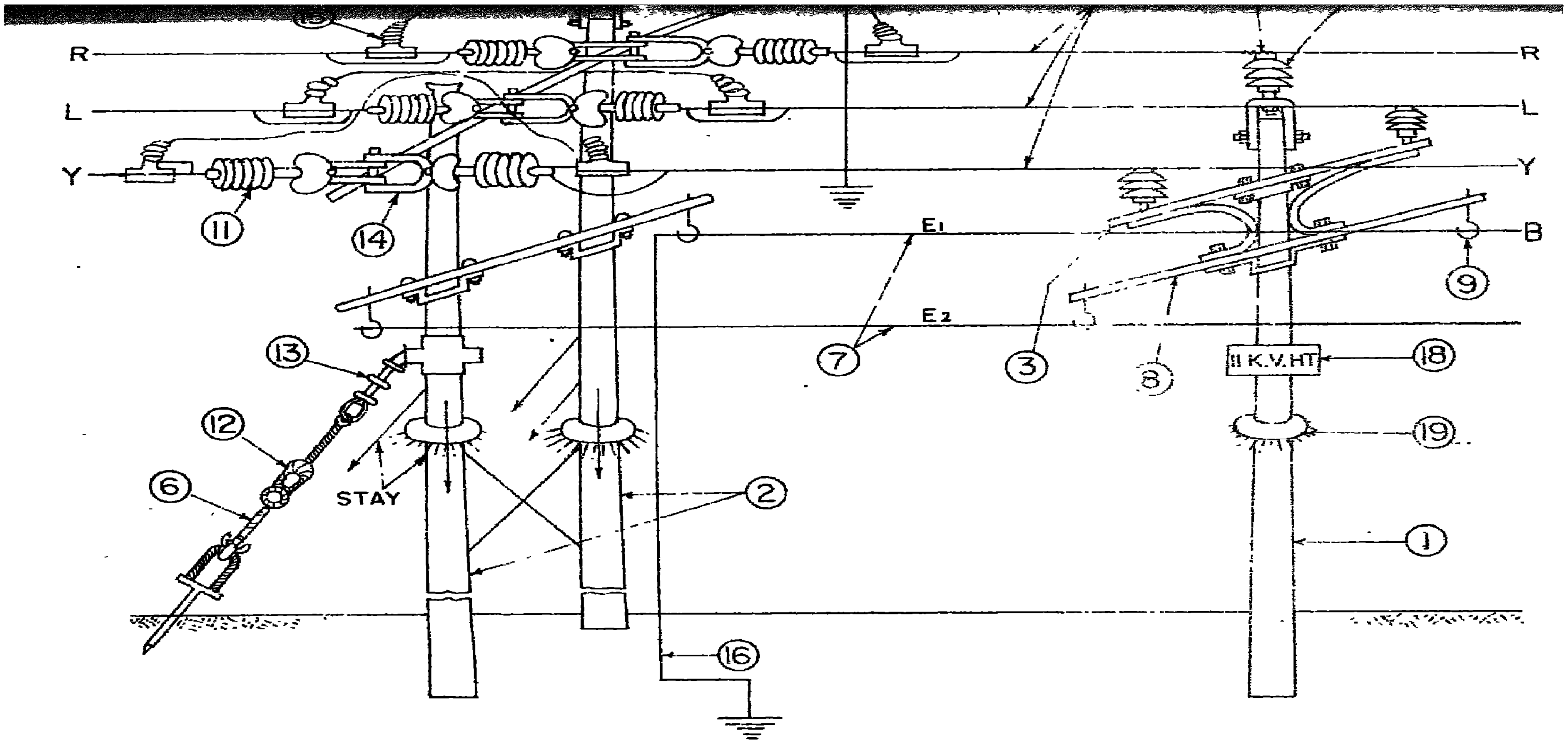
1. Transmission and Distribution

by

Rawly and Mittal


NEUTRAL CUM EARTH WIRE
750
3000
L. T. LINE
℄ OF THE ROAD
SPOOL INSULATOR
POLE
ANGLE NOT LESS THAN 60°
℄ OF THE ROAD

PLAN



MAIN COMPONENTS OF OVERHEAD LINES

1. SUPPORT (R.C.C. POLE)
2. DOUBLE POLE STRUCTURE
3. CROSS- ARM
4. PIN TYPE INSULATOR
5. LINE CONDUCTORS
8. ANGLE IRON FOR EARTH WIRE
9. HOOKS FOR EARTH WIRE
10. TOP HAMPER
11. STRAIN INSULATOR
12. STAY INSULATOR
15. P.G CLAMP
16. EARTHING
17. LIGHTNING ARRESTOR
18. DANGER PLATE

EXPERIMENT/PRACTICAL NO.12

1. TITLE OF EXPERIMENT/PRACTICAL

Drawing of poles showing their fittings.

2. SPECIFIC OBJECTIVE

To acquaint lineman with various types of poles, and their fittings, used in overhead lines.

3. INTRODUCTORY INFORMATION AND RELATED THEORY

(a) Information· Poles are used as support to carry overhead lines. Different type of poles are used depending upon the voltage of the O.H. lines.

(b) RELATED THEORY

Overhead lines are laid to transmit electricity from one place to another. To carry electricity upto 66 K.V. different type of poles such as tubular pole, P.C.C. pole, R.C.C. pole, rail girders, wooden poles, etc. are used. The choice of pole depends upon the length of span and voltage of electricity to be transmitted. Normally, wooden poles are used in hilly areas only, where, there is abundance of wood and it is very difficult to carry other poles from plains due to difficulty in transportation. These days, R.C.C. poles are normally used in overhead lines due to their low cost.

4. EQUIPMENT AND MATERIALS

1. Pencil and Rubber.
2. Drawing sheet and Drawing board.
3. Scale.

5. PROCEDURE·

1. Study the different types of poles and towers as in the attached drawing No.12.1

2. Make drawings of all type of poles.

6. QUESTION FOR EVALUATION

(i) Why R.C.C. poles are preferred to other types of poles?

(ii) Why wooden poles are generally used in hilly areas?

(iii) Name the various fittings of an 11 K.V. line pole.

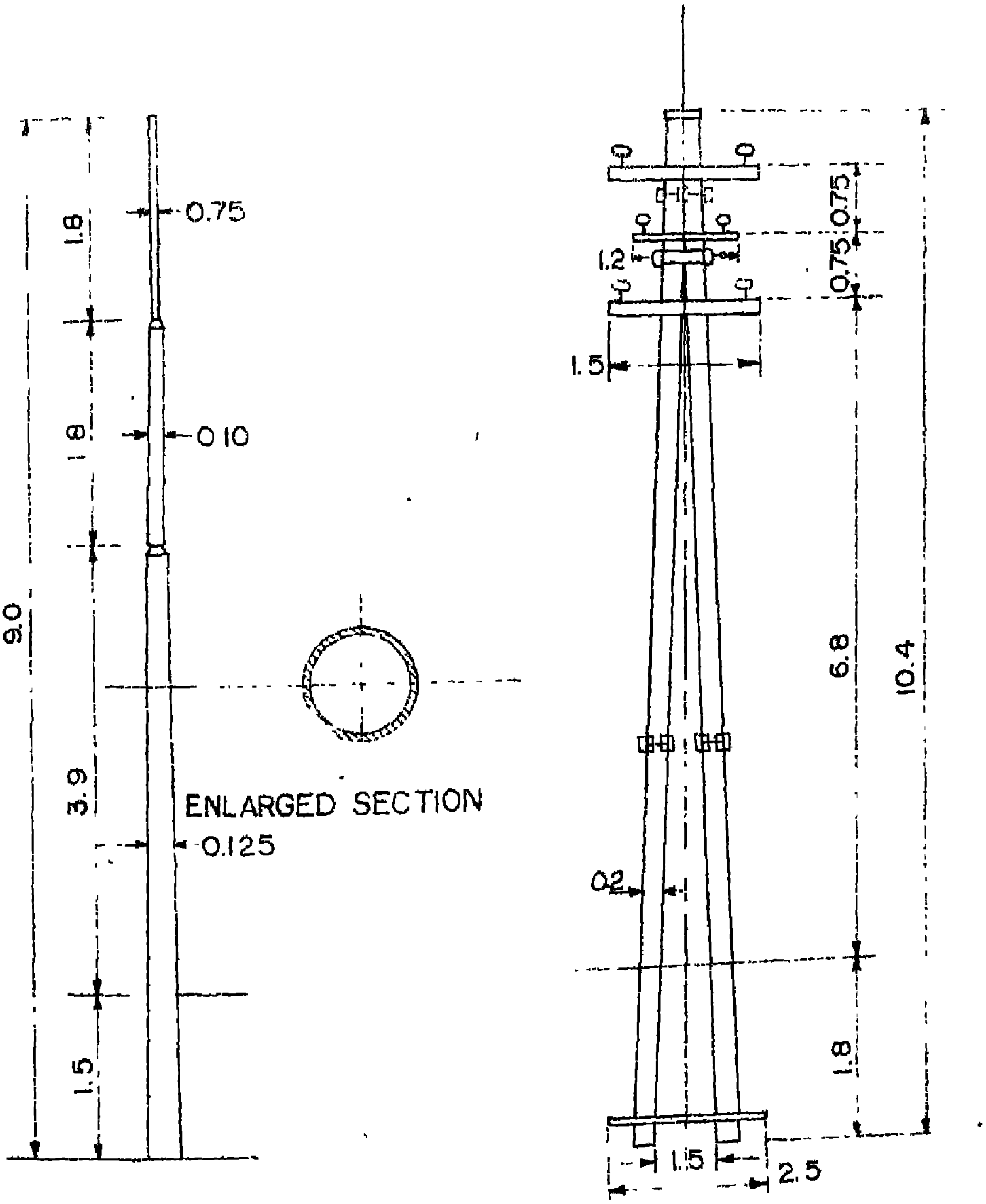
(iv) On what factor, does the length of pole to be used, depend?

(v) Is there some minimum length of a pole to be used for transmitting a particular line voltage?

References:

1. A Hand book of Electrical Engg.
by S.L. Bhatia.
2. Electrical Power by J.B. Gupta

POLES & TOWERS(I)

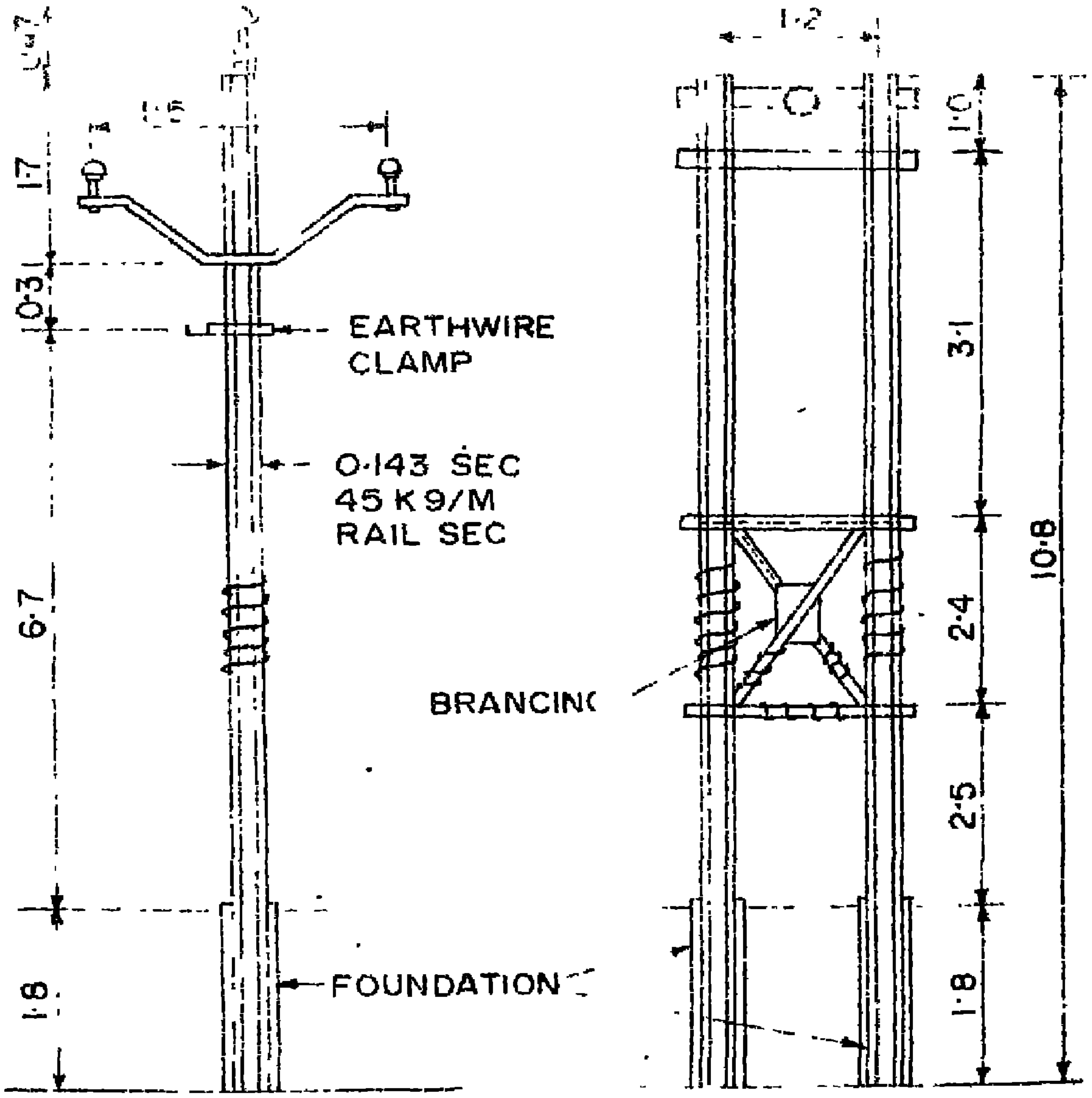


TUBULAR STEEL
POLE FOR L.T LINE

DOUBLE CIRCUIT 11 KV
'A' TYPE WOODEN POLE

Fig. 12·1

POLES & TOWERS(2)

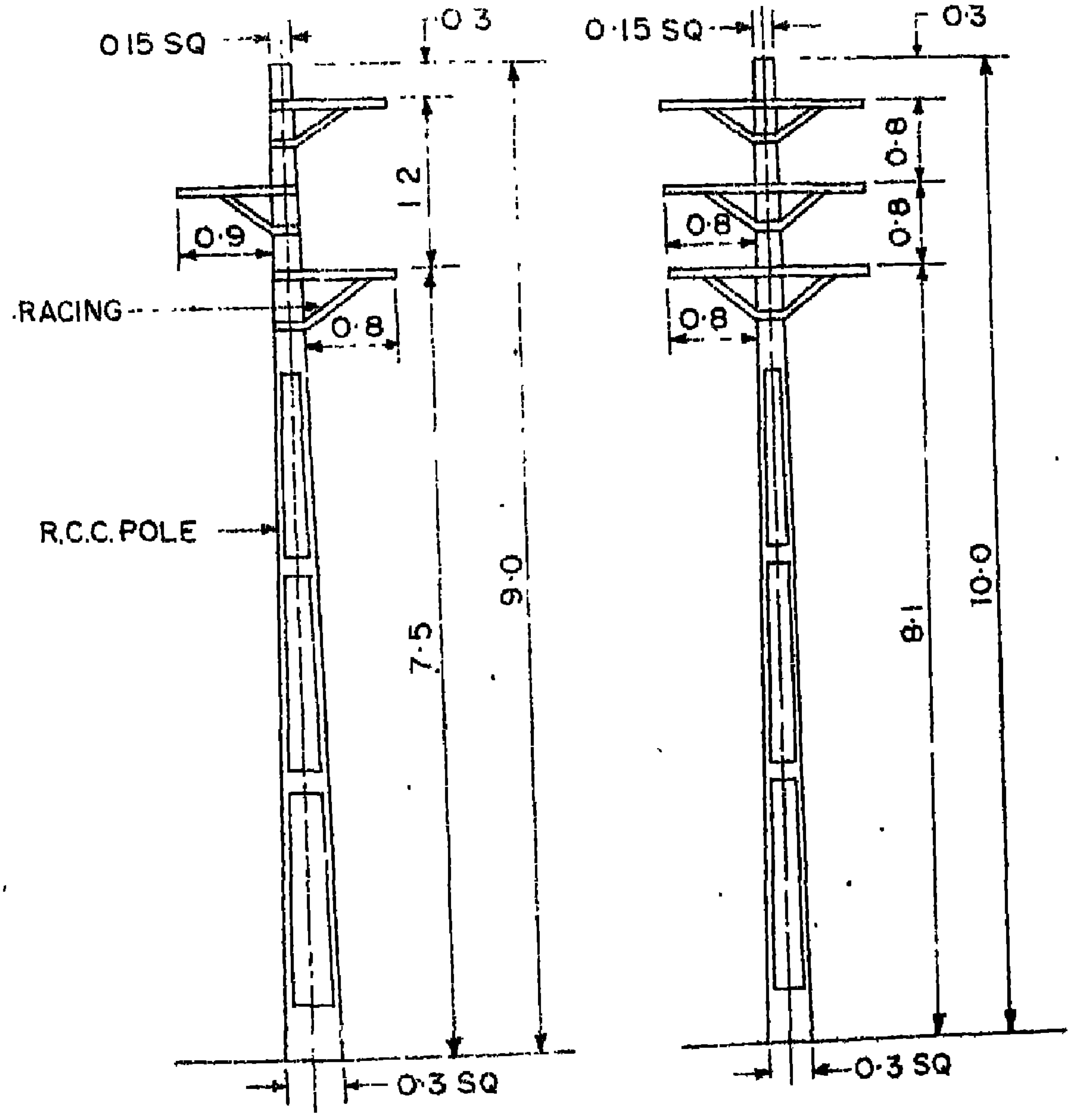


SINGLE CIRCUIT 33KV INTERMIDIATE RAIL POLE

'H' TYPE 11KV TERMINAL POLE

Fig. 2·1

POLES & TOWERS(3)



SINGLE CIRCUIT, 11 KV
CONCRETE POLE

DOUBLE CIRCUIT, 11 KV
CONCRETE POLE

Fig. 12·1

EXPERIMENT/PRACTICAL NO.13

1. TITLE OF EXPERIMENT/PRACTICAL

Drawing of towers.

2. SPECIFIC OBJECTIVE

To acquaint lineman with various types of towers and their fittings used in transmission lines.

3. INTRODUCTORY INFORMATION AND RELATED THEORY

(a) INFORMATION: Steel towers are the line supports used in transmission lines 66 KV and above.

(b) RELATED THEORY

High Tension lines need to have a bigger gap between ground and the line, and large spans and therefore require larger height than that of poles. Since a pole cannot sustain the wind load coming on the line as such stronger structure is required hence the tower.

The various types of steel towers which are available are single circuit and double circuit. The construction and height of steel towers depend upon the voltage and the length of span.

4. EQUIPMENT AND MATERIAL

1. Pencil and Rubber.
2. Drawing sheet and Drawing board.
3. Scale.

5. PROCEDURE

1. Study the different types of towers in the attached drawing No.13.1
2. Make drawings of all types of towers.

6. QUESTIONS FOR EVALUATIONS

(i) What is meant by single circuit tower?

(ii) What is meant by double circuit tower?

(iii) What is the height of double circuit steel tower for 220 KV line?

(iv) Is there any difference in single circuit steel tower for 220 KV and 400 KV?

(v) Why earth wire is run at the top of tower?

(vi) Why barbed wire is wound around towers?

References:

1. A Hand book of electrical Engg.

by

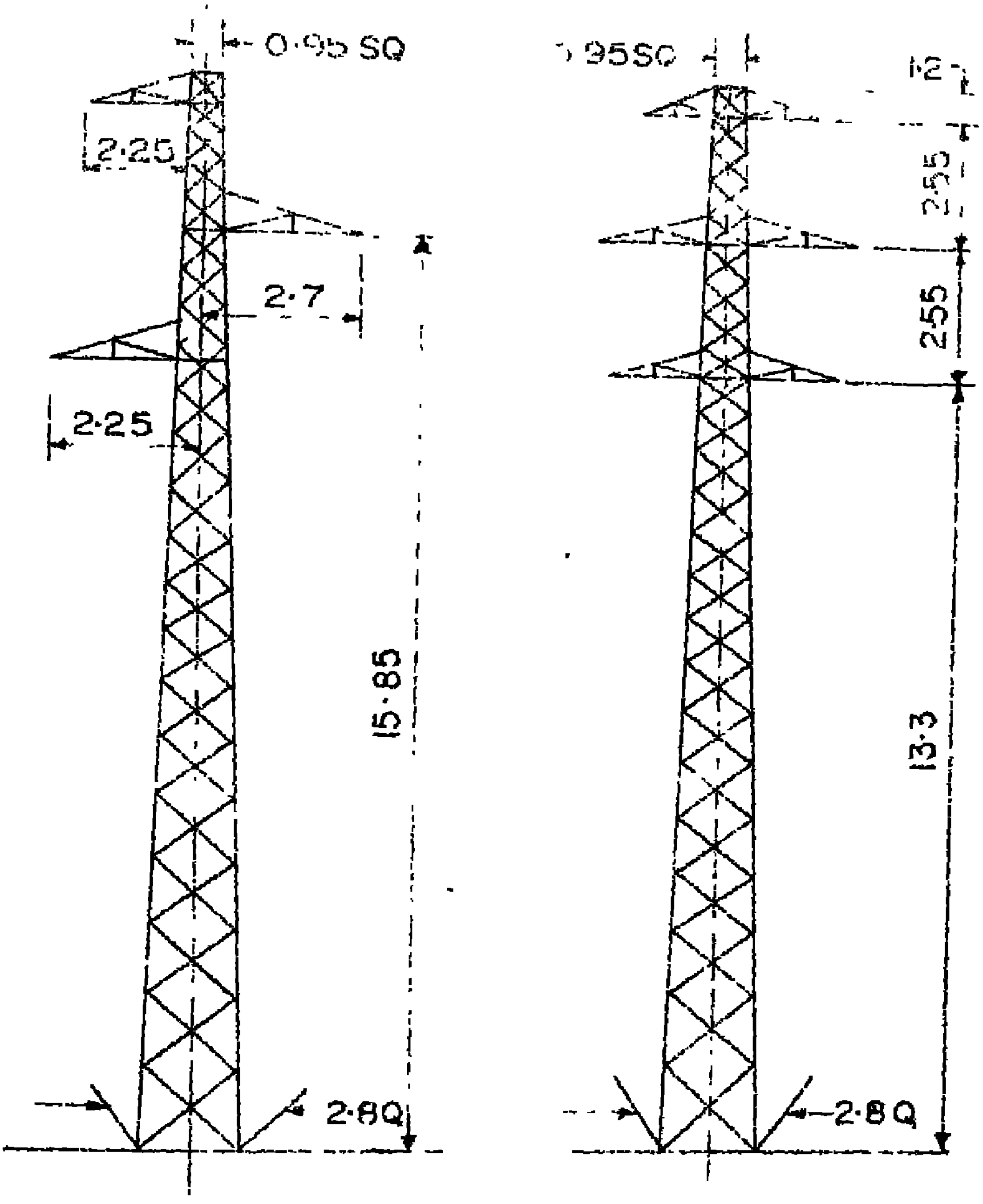
S.L. Bhatia.

2. Electrical Power

by

Dr. S.L. Uppal.

TOWERS(1)

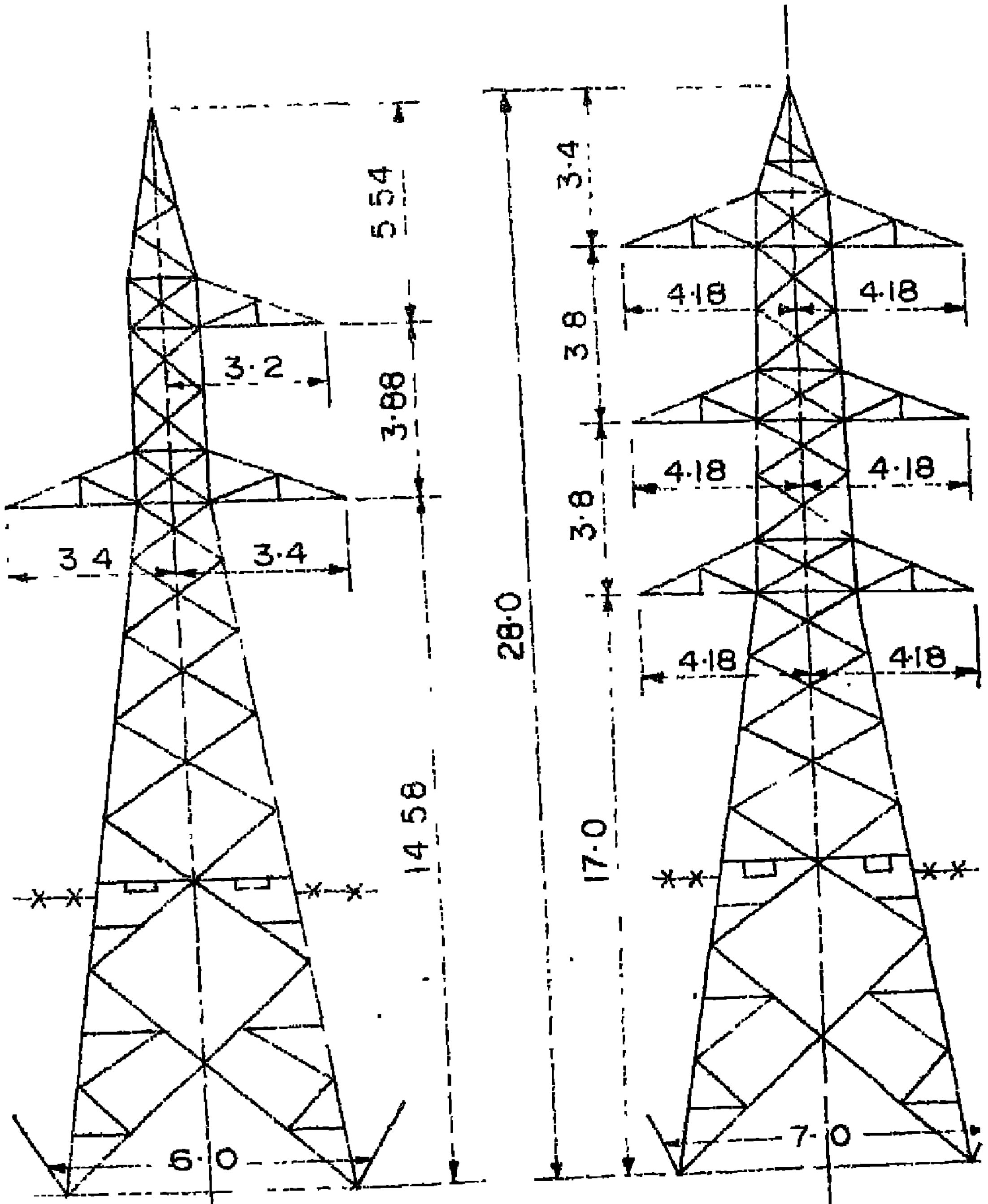


SINGLE CIRCUIT
66 KV STEEL TOWER

DOUBLE CIRCUI
66 KV STEEL TOW

Fig. 13·1

TOWERS (2)



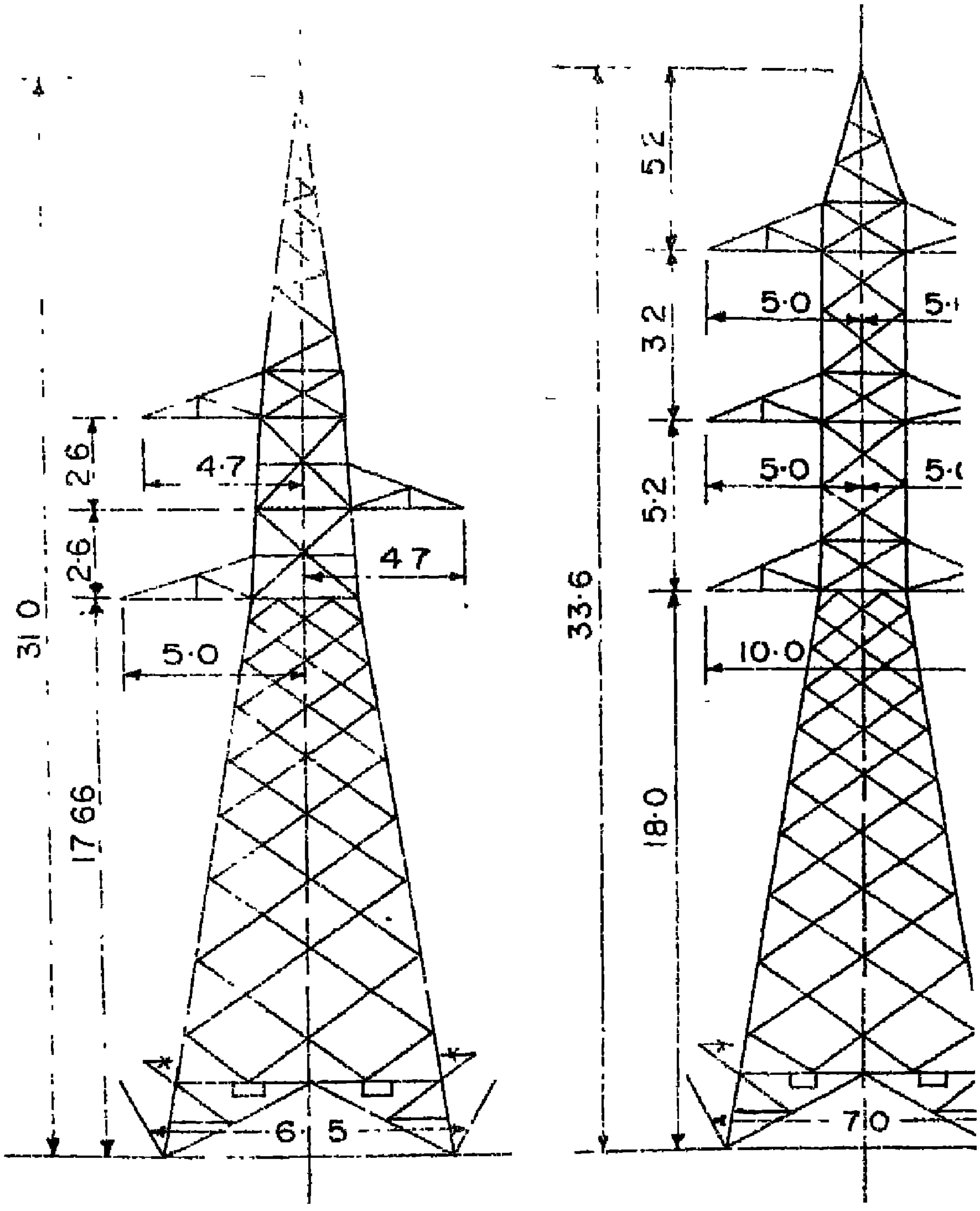
SINGLE CIRCUIT

DOUBLE CIRCUIT

132 KV STEEL TOWERS.

Fig. 13.1

TOWERS(3)

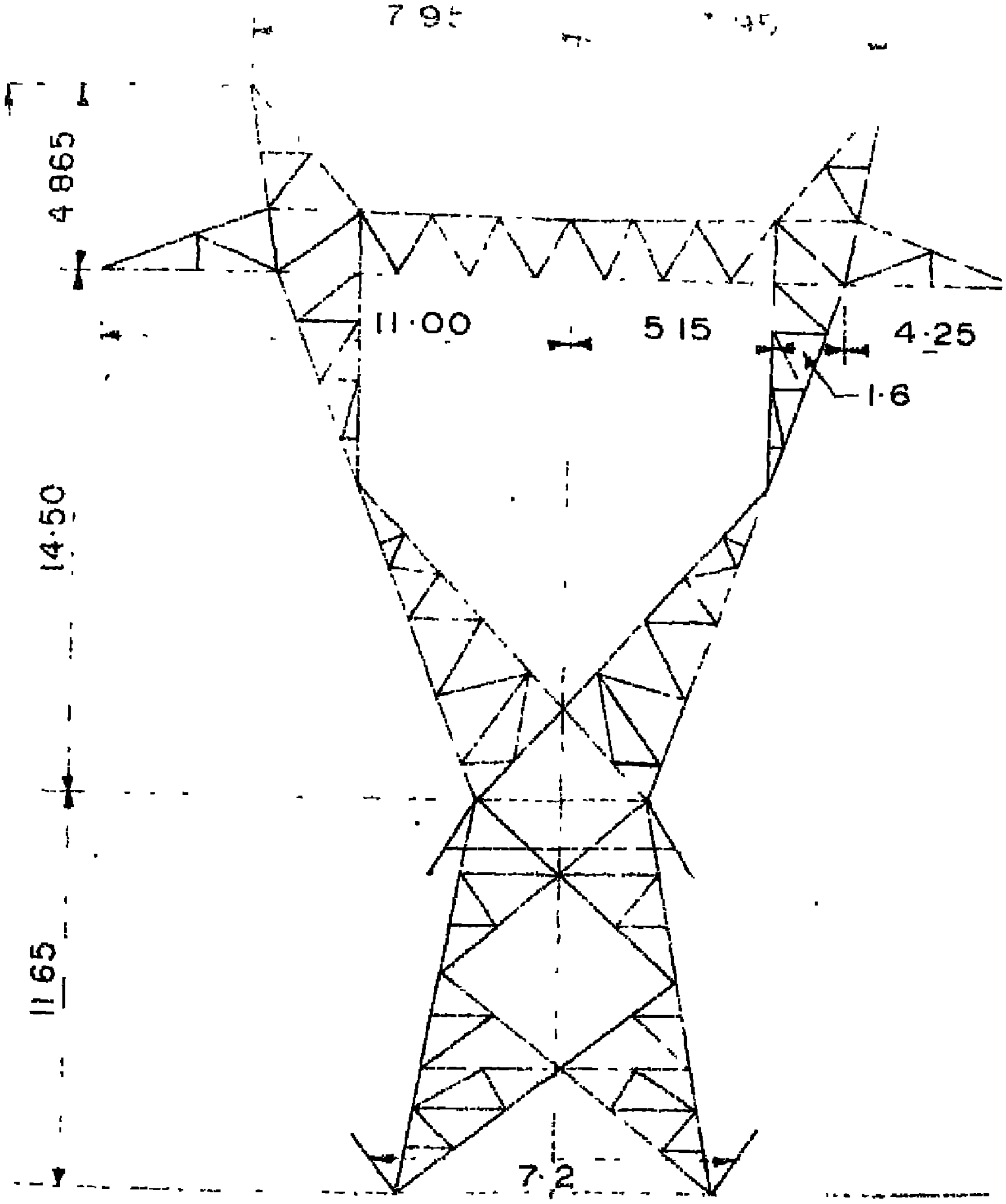


SINGLE CIRCUIT DOUBLE CIRCU

220 KV STEEL TOWERS

Fig.13.1

TOWERS(4)



SINGLE CIRCUIT 400 KV
STEEL TOWER

Fig·13·1

EXPERIMENT/PRACTICAL NO.14

1. **TITLE OF EXPERIMENT/PRACTICAL**

Study of Panel Board, Busbar and substation circuit.

2. **SPECIFIC OBJECTIVE**

To acquaint a lineman with the drawings of Panel Board, busbar and substation circuit.

3. **INTRODUCTORY INFORMATION AND RELATED THEORY**

A lineman has to work in the construction and maintenance of substations and hence he must have the ability to read the drawings of substations etc.

There are two types of substations, indoor substations and out door Substations (S/S). Indoor S/S are normally located at load distribution centre and are constructed upto 11 K.V. voltage. The out door S/S are made beyond 11 KV and are normally of 33 KV, 66 KV, 132 KV, 220 KV & 400 KV.

4. **EQUIPMENT AND MATERIAL**

1. Pencil and Rubber
2. Drawing sheet and Drawing Board.
3. Scale.

5. **PROCEDURE**

1. Study the drawing No.14.1
2. Make drawing of drawing No.14.1 and other S/S drawings available.

6. **QUESTION FOR EVALUATION**

(i) What are the various electrical symbols used in drawings of a S/S ?

(ii) What are the type of S/S ?

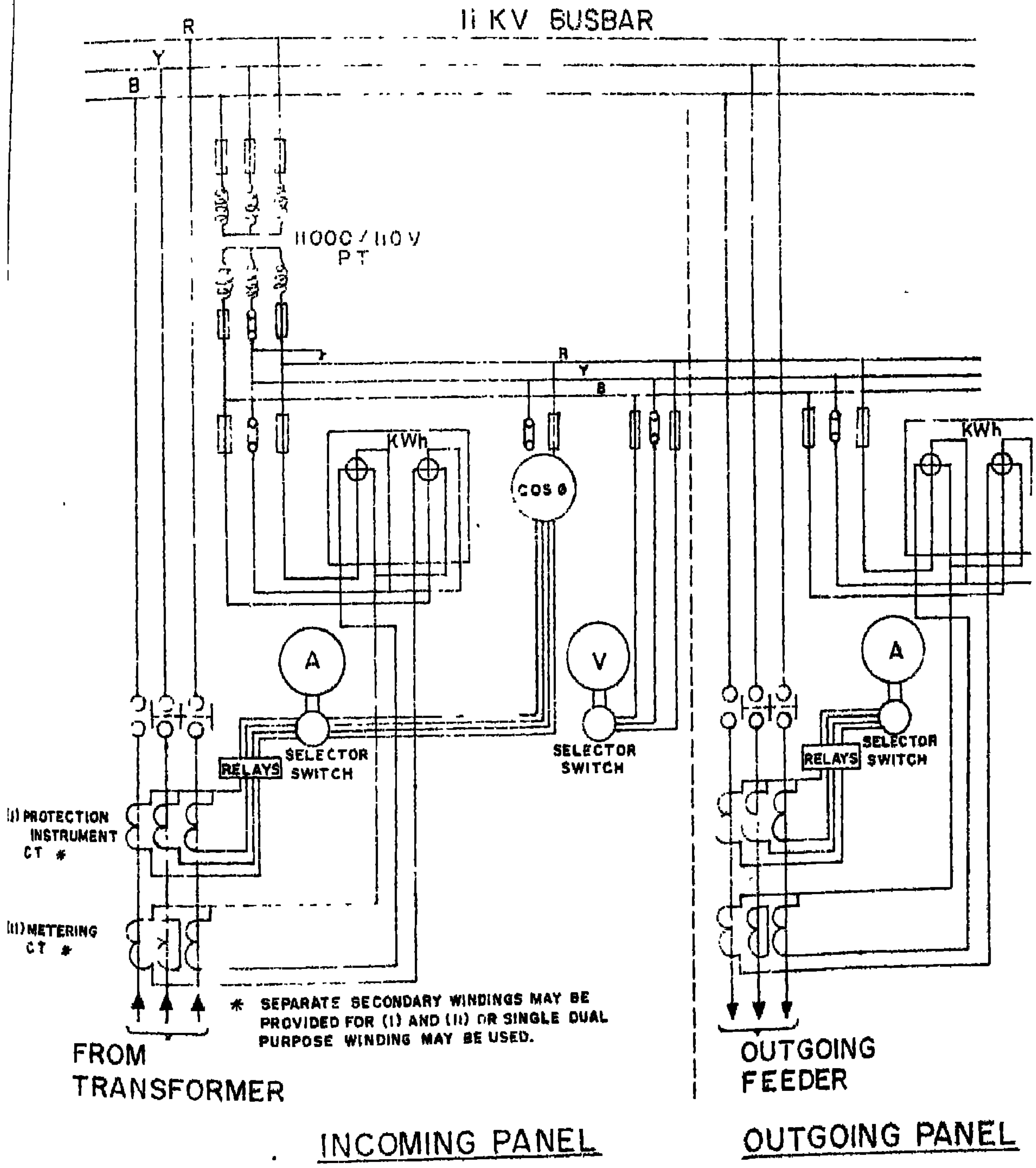
(iii) Give the voltage ratings of indoor and outdoor S/S.

(iv) What is ideal location for an outdoor S/S?

(v) Why indoor S/S are located at load distribution centre?

References.

1. A Hand book of Electrical Engg.
by S.L. Bhatia.
2. Electrical Power by Dr. S.L. Uppal.



* SEPARATE SECONDARY WINDINGS MAY BE PROVIDED FOR (I) AND (II) OR SINGLE DUAL PURPOSE WINDING MAY BE USED.

NOTES-

1. EACH OF THE INCOMING AND OUTGOING 11KV PANELS SHOULD BE PROVIDED WITH A KWh METER AND AN AMMETER FOR PROPER ASSESMENT OF LOSSES IN ADDITION, EACH INCOMING PANEL SHOULD HAVE A VOLTMETER IN CASE THERE ARE NO INCOMING PANELS, A VOLTMETER SHOULD BE PROVIDED ON ONE OF OUTGOING PANELS
2. ONLY ONE PT AND ONE POWER FACTOR MASTER NEED BE PROVIDED AT EACH SUB-STATION

33/1KV SUB-STATION METERING ARRANGMENT

Fig. 141

EXPERIMENT/PRACTICAL NO.15

1. TITLE OF EXPERIMENT/PRACTICAL

Use of pulley blocks and lifting tackles.

2. SPECIFIC OBJECTIVE

To learn the use of pulley block and tackle for lifting of poles etc.

3. INTRODUCTORY INFORMATION AND RELATED THEORY

To lay the over head transmission lines in remote as well as suburb areas, sophisticated lifting machines cannot be transported to the site, as such the lineman is required to know the use of simple lifting machines like pulleys, pulley block and tackles.

Pulleys and Pulley Block and Tackle alongwith the rope are used for lifting purpose. The efficiency of pulley lifting systems are sufficiently high and is in the range of 80%. The mechanical advantage of these lifting systems can be increased by increasing the velocity ratio. The velocity ratio of the system can be increased by increasing the numberof pulleys around which rope is wound. For this machine, the following relationship holds good.

Efficiency x Velocity Ratio = Mechanical Advantage.

4. EQUIPMENT AND MATERIALS

(i) Tri-pod

(ii) Pulley Block and Tackle.

(iii) Lifting Rope.

(iv) Slings

(v) Poles to be lifted.

5. PROCEDURE

(i) Errect the tri-pod near the pit.

(ii) Bring the base of the pole near the pit so that it can be slided into it by lifting.

(iii) Tie the rope to the pulley block and tackle and pull the other end of the rope through the small pulley on the tripod and lift the block and tackle upto the height of the eye of the tripod.

(iv) Insert the hook of the block and tackle into the eye of the tripod.

(v) Operate the mechanism and lower the lifting hook of the pulley block.

(vi) Tie the sling around the pole at the appropriate place and attach it to the lifting hook.

(vii) Operate the lifting mechanism slowly and keep on adjusting the position of the pole from time to time.

(viii) Lower the base of the pole into the pit and bring the pole to the vertical position and secure it.

(ix) Pull the lifting rope to free the pulley block and tackle from the eye of the tri-pod.

(x) Lower the Pulley Block and Tackle and dismantle the Tripod.

6. PRECAUTIONS

(i) Use suitable Pulley block and tackle depending upon the load to be lifted.

(ii) Errect the tri-pod properly so that equal load is shared by all the legs .

(iii) Use a strong rope to lift the pulley block and tackle.

(iv) Attach the sling to the pole above its center of gravity,

(v) Do not perform the lifting of poles with jerks.

7. QUESTION FOR EVALUATION

(i) What do you understand by mechanical advantage?

(ii) Give the relationship of Mechanical advantage, velocity ratio and efficiency.

(iii) What are the various sizes of pulley block and tackle.

(iv) Why is the pulling chain of the pulley block and tackle self-locking?

(v) What is the disadvantabe of jerking during lifting?

References:

1. Applied Mechanics by Gurbax Singh
2. Applied Mechanics by Sadhu Singh

APPENDIX-I.

LIST OF CONTRIBUTORS

1. Shri G.B.Singh
   3/235 Subhas Nagar
   New Delhi.

2. Shri R.K.Saxena
   Assistant Professor (Elect. Engg.)
   Curriculum Development Centre
   Institute of Engineering and Rural Technology
   26 Chatham Lines (Prayag)
   Allahabad-211002 (U.P.)

3. Shri V.K.Singla
   Assistant Executive Engineer
   Linemen Training Centre
   Haryana State Electricity Board
   Sector-18, Faridabad-121002.

4. Shri J.S.Kalra
   Lecturer in Mechanical Engineering
   Delhi College of Engineering
   Kashmere Gate, Delhi-110006.

5. Shri P.C.Singhal
   Head, Electrical Engineering Department
   Arya Bhat Polytechnic
   G.T.Karnal Road, Delhi-110033.

6. Shri H.L.Bhutani
   Principal, ITI - AVTS
   Industrial Training Institute
   Faridabad-121001(Haryana)

7. Shri A.P.Verma
   Reader in Technology
   Department of Vocationalization of Education
   N.C.E.R.T., NIE Campus
   Sri Aurobindo Marg, New Delhi-110016.

8. Shri Sachchidananda Roy
   Lecturer in Technology
   Department of Vocationalization of Education
   N.C.E.R.T., NIE Campus
   Sri Aurobindo Marg, New Delhi-110016.

REVIEW AND EDITING COMMITTEE

1. Shri P.C.Singhal
Head, Electrical Engineering Department
Arya Bhat Polytechnic
G.T. Karnal Road, Delhi-110033.

2. Shri J.S.Kalra
Lecturer in Mechanical Engineering
Delhi College of Engineering
Kashmere Gate, Delhi-110006.

3. Shri Sachchidananda Ray
Lecturer in Technology
Department of Vocationalization of Education
National Council of Educational -
Research and Training
Sri Aurobindo Marg, New Delhi-110016.

APPENDIX -III

Questionnaire for Collecting Opinion of Teacher's and Students

on the

Instructional-cum-Practical Manual

on

BASIC MATERIALS AND RELATED WORKSHOP

for

Lineman Vocation Class -XII

(Experimental Edition)

1 9 8 4

DEPARTMENT OF VOCATIONALIZATION OF EDUCATION
NATIONAL COUNCIL OF EDUCATIONAL RESEARCH AND TRAINING
SRI AUROBINDO MARG, NEW DELHI - 110016.

Dear Teacher/Students,

We are happy to place this Manual at your disposal with the hope that it will help you to conduct the practical works prescribed in the syllabi and to gain required competencies through vocational experience.

This Manual conforms to the syllabi of Lineman Vocation Class-XII offered by the State of Haryana and includes most of the important activities to be performed by a Lineman. This is an experimental edition with ample scope for further improvement through feedback from you. We solicit your active cooperation for the improvement of the Manual.

After having used this Manual for a year or more, kindly read the appended questionnaire carefully and write down the answers precisely and exactly to the point. You may use additional sheets of paper, 'if the space provided' is insufficient. The questionnaire may be mailed at the following address:

Shri SACHCHIDANANDA RAY
Programme Co-ordinator
Department of Vocationalization of Education
National Council of Educational
Research and Training
Sri Aurbindo Marg
New Delhi-110016.

QUESTIONNAIRE FOR THE TEACHERS

INSTRUCTIONAL-CUM-PRACTICAL MANUAL ON____________________

A. Name of the Teacher
(in block letters) ____________________

B. Name & Postal Address
of the Institution____________________

____

____

C. i. Qualification____________________

ii. Teaching Experience____________________

iii. Professional or
Field Experience____________________

____

1. Do the activities covered in the Manual develop vocational expertise in the students?

YES/NO

2. List the activities included in the Mannual which do not figure in the syllabus.

3. List the activities included in the Manual which do not figure in the syllabus, but are vocationally important.

4. List the activities prescribed in the syllabus but not covered in the Manual.

5. List the vocationally important activities which are neither included in the Manual nor prescribed in the syllabus.

6. a) Does the relevant information given under every activity unit furnish enough theoretical background of the activity?

Yes/No

b) If not, list the activity units where relevant information needs further modification.

Activity Unit	Portion	Type of modification needed

7. a) Does the relevant information contain any factual errors or inaccuracies?

Yes/No

b) If yes, give the details

Activity Unit	Error/Inaccuracy	Should read

8. Did you notice any expressions/sentences in the manual which do not carry precise meaning or information? If yes, then give the details:

Page No.	Expression/Sentence	Would be more appropriate

9. Are instructional objectives pertaining to each activity unit rational? If not, list down the irrational, irrelevant or vague ones.

Activity Unit	Irrational/irrelevant/Vague objective

10. Does accomplishment of the activity units result in realization of objectives in terms of behavioural outcomes in the pupil? If not point out the behavioural outcomes mentioned in the manual, which you feel are difficult to achieve through a particular activity Unit?

Activity Unit	Behavioural outcom

11. Is the procedure for activity units well sequential? If not point out the discrepancies along with your own observations or suggestions.

Activity Unit	Discrepancy	Observation/ Suggestions

12. Did you notice any inaccuracies/discrepancies in the diagrams illustrating activity units? If yes, point them out.

Illustration No.	Discrepancy/ Inaccuracy

13. Your overall opinion about the Manual which may be useful in the effective improvement of the manual.

QUESTIONNAIRE FOR THE PUPILS

INSTRUCTIONAL-CUM-PRACTICAL MANUAL ON____________________

A. Name of the pupil
(in block letters)____________________

B. Name and address of
the School/College____________________

C. Class____________________

D. Medium of instruction____________________

1. Enlist the portions of the manual which you found difficult to understand and give reasons.

Activity Unit	Portion of the Text	Difficulty experienced

2. Mention the places where you found the language to be difficult.

Activity Unit	Page No.	Difficulty experienced

3. Point out the figures/illustrations which do not help in understanding the topic/theme.

Illustration No.	Your observations/ difficulty experienced

4. Can you conduct the activity units yourself with the help of this manual?

Yes/No

If not, point out the portions of activity units which need further elaboration or explantion.

Activity Unit	Portions to be elaborated

5. Was theoretical information given in the Manual useful to you in the examination?

Yes/No

6. Do you know the scientific reasons behind steps that you take in the conduct of different activity units?

Yes/No

7. Your overall opinion about the Manual.